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ARTS AND SCIENCES

OR

Fourth Division of "The English Cyclopædia,"

CONDUCTED BY

CHARLES KNIGHT.

VOLUME V.

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ARTS AND SCIENCES.

VOLUME V.

JOINERY, the art of uniting wood of small dimensions, for the purpose of forming those fixed details of house- or ship-building which are not connected with the solid framework of the structure: and it is usually understood that the term *joinery* is applied to this particular branch of the constructive arts, in contradistinction to the other branches, *carpentry* and *upholstery*, the former of which deals exclusively with the wooden framework of buildings, and the latter with the moveable furniture. The articles ordinarily comprised within the province of the joiner's art are doors, windows, shutters, floors, staircases, cupboards, counters, shop-fronts, &c.; and the respective descriptions of work are either plain, framed, or panelled. In order to ensure their proper execution, it is necessary that the joiner should be acquainted—1, with the nature and properties of wood; 2, with the modes of putting the wood together, alike with reference to the economical conversion of the wood, the strength of the assemblage, and the resistance to atmospheric changes; and 3, the general principles of taste, in so far as they may influence the character of the work.

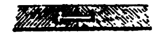
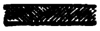
1. *The woods* most commonly used for joiners' work in England are the various kinds of fir and pine imported from the north of Europe and from America; oak, either native or foreign; mahogany, rosewood, cedar, maple, satin-wood, though perhaps the three last-named materials may be, more strictly speaking, regarded as furniture woods. Locally, poplar, chestnut, walnut, ash, beech, and some kinds of birch are used; but the practice of London joiners is almost exclusively confined to fir, oak, and mahogany.

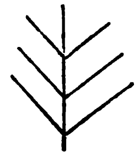
The fir-woods used for joinery are technically known under the names of *baulk*, or of *manufactured goods*, including under the latter term *planks*, usually 11 inches wide by 3 inches thick; *deals*, 9 inches wide by 3 inches thick; and *battens*, 7 inches wide by 2½ inches thick; but it is to be observed that it is only in country districts, or where very coarse work is admissible, that baulk timber is converted to these uses. The planks, deals, and battens are, again, either of white or yellow deal, from the Baltic or Norwegian ports; or they are of white, yellow, or pitch pine, or more recently of the Vancouver's Island wood, all of which are obtained from America. The best European yellow deals come from St. Petersburg, or Gefle; the best white deals, from Archangel or Christiania; but the Stockholm, or the Riga and Memel deals, of either description, are of very nearly equal quality. Yellow deal is more fitted for doors or other panelled work than white deals, because it is less subject to warp or shrink; but the white deals are harder than the yellow ones, and therefore are more used for flooring purposes. Both white and yellow deals require, however, to be seasoned, or exposed to the air in sheltered positions, for at least from four to six years, before being employed for superior descriptions of joiner's work. The ordinary American pine deals are of a very inferior quality, whether as to grain or durability, and their use has been almost entirely abandoned by English joiners since the differential duties upon foreign timber have been reduced; but the yellow pine is still largely used, on account of its uniformly soft character, the straightness and beauty of its grain, and its immunity from knots; and for these reasons it is employed for moulded work, and for pianoforte making. The pitch-pine is a very beautiful variety of the fir woods, of a rather deeper and warmer colour than the yellow pine, and of much greater strength and durability; unfortunately, however, it is very costly, and is, therefore, only used in cases where particularly sound and durable work is required, as for ships' decks, floors, staircases in good houses, &c. But the Vancouver's Island timber seems to possess qualities of durability, resistance to atmospheric changes, and colour, which place it in a very superior category to any other description of fir wood, for those joiner's purposes at least wherein it may not be absolutely necessary to work the wood against the grain. The use of this Vancouver's Island timber has not, however, been sufficiently proved by experience to warrant its application on a very large scale.

The oak used in England is either obtained in the country or is imported from Germany, or America, or Italy; and it either comes to market in the shape of baulk, log, or plank stuff, whilst in France short ends, known as *merrains*, are much used for flooring purposes. The baulk oak is used for making door- and window-cills for the best description of houses; and as those articles of joinery are exposed to alternations of moisture and dryness, it would be desirable to use for them nothing but English oak, which resists those destructive actions better than either the German or Italian oak, and infinitely better than the American oak. For the more ornamental descriptions of joiners' work wainscot logs are used, after having been sawn into plank stuff and properly seasoned. The best of these logs are obtained from the woods of the interior of Germany, and they are exported from Riga under the name of *Dutch wainscot*. This material, when properly seasoned, is not liable to warp or to shrink; it blackens with age, but is always susceptible of receiving either a varnish or a polish; its texture is by no means unfavourable for working mouldings, either with or against the grain; it is very durable, strong, and hard, but by reason of the latter property the labour upon it becomes considerably greater than the labour upon deal or pine. Wainscot has one great advantage over ordinary deal or pine—namely, that it does not require to be painted; and though the Vancouver's Island timber, or the pitch-pine, may dispense with that mode of decoration or protection, their colours and *flower* (as workmen call the variations of tint or pattern in the different parts of the wood) are certainly not so pleasing as those the wainscot. For delicate wood-carving, the yellow pine is unquestionably superior to any other wood, because it is both softer and more uniform in its texture; but wainscot is very well fitted for such purposes, and the elaborate carving of the mediæval pulpits, stalls, confessionals, &c., may be cited as affording illustrations of the success with which this wood may be applied to the higher branches of the arts. The very remarkable pulpits and confessionals of Belgium and of Northern Germany may be especially referred to on this score.

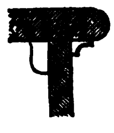
The best mahogany which is introduced into this country for joiner's work is the produce of the southern part of the island of Hayti; the mahogany from the northern part of that island is of an inferior quality, and approaches very nearly the character of the worst descriptions of Honduras wood. The logs exported from Cuba are often very beautiful, indeed almost equal to the best Hayti (or, as it is technically called, the *Spanish* mahogany); but it is not of such large dimensions as the Honduras wood, nor is it so uniform in the beauty of its flower as the Spanish. The best Honduras mahogany is very well adapted for ordinary works and for ship-building; but it is usually of a straight grain, without any varieties of tint, and is not therefore fitted for such works as hand-rails, doors, counter-tops, &c., where variety of colour is required. The commoner descriptions of Honduras wood are only used for carriage-builders' purposes, for interiors of drawers, or even for ship-building; and for all these purposes their low price, their great strength and durability, and their singular freedom from any tendency to warp or crack, make them very desirable. Mahogany of any description is worked evenly, but with difficulty, and on those accounts the labour upon it is expensive; for ornamental carving it is admirably adapted but as it turns almost black with age, the original effect of the carving may be lost. This wood is susceptible of both oil and spirit varnish or polish.

2. The modes of putting work together must of course depend upon the particular object it may be desired to accomplish; and perhaps the most convenient mode of describing them would be to take illustrations from some of the more generally known articles of joiner's work.

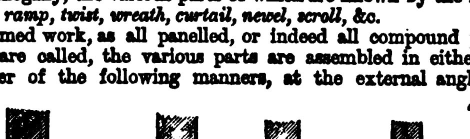
In floors it is usual, especially in countries where fir or any of its varieties is commonly employed, to execute them with boards cut as nearly as possible to an even thickness. The upper surface of the boards is then planed, the edges shot, and a narrow border is worked on the under side, exactly parallel with the upper surface, leaving an intermediate space to be adzed off when the boards are to be fixed. In the best floors, narrow boards only should be used, of between 4½ and 6½ inches, in finished width; or in fact, they should be formed out of deals, with a cut down the middle, or out of battens; the *joints* should be *straight*, *grooved* and *feather-tongued* (or with a groove worked in each board, and filled in with a thin slip of wood, or of iron, as in sketch ), and the *heading-joints* should be *splayed* thus ; sometimes, instead of grooving and tongueing the boards, they are merely *edge-nailed*. Where the boards come near hearths, a glued and mitred border should be introduced, even when the floor boards are not intended to be habitually exposed. In the floors of bed-rooms, or of apartments wherein carpets or matting are likely to be permanently used, the boards may, without inconvenience, be 9 inches in width; and in warehouse floors they may be made 12 inches wide. Upon the continent, and in some cases in our own country, however, where wainscot floors are used, the narrow boards are laid in what is call *herring-bone fashion*, as in sketch; but in such cases the floors are always left uncovered, and they are waxed, or dull polished. The thickness of floor boards would naturally depend on the wear they are likely to be exposed to, and upon the distance apart of their points of support; as a general rule it varies between 1¼ and 1 inch.

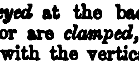


In staircases of wood, the usual practice is to frame the *treads*, or the horizontal parts of the steps, and the *risers*, or the vertical parts, into *wall* and *outside strings;* the former of which is a stout piece of wood nailed against the walls of the *well-hole* of the stairs, and the latter, an equally stout piece of wood starting from a *curtail step* at the bottom of the stairs, and either framing into a solid post, or *newel*, in what are called *dog-legged staircases*, or carried round by means of curved ramps to the trimmer of the upper landing in *geometrical staircases*. The *risers* are usually grooved into the under side of the treads, and the latter project so as to form a *nosing*, whilst the joint is hidden by a small hollow, nailed to the underside of the tread; small blocks are glued to the inside of the joint, and, if the width of the staircase be considerable, the frame-work is strengthened by means of brackets let into the wall, and by blocks. In some staircases the outside string is cut, and the nosings are returned at the ends of the steps; in others, the string projects above the ends of the steps. The ballusters in the former case are let into the steps; in the latter, they are let into the string-board; but under all circumstances the ballusters are fixed at top to a hand-rail, usually worked out of solid mahogany, the various parts of which are known by the names of *straight*, *ramp*, *twist*, *wreath*, *curtail*, *newel*, *scroll*, &c.



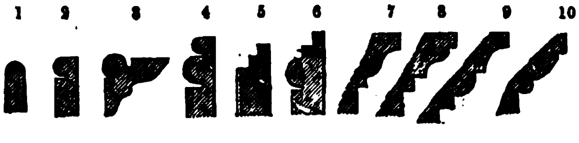
In framed work, as all panelled, or indeed all compound pieces of joinery are called, the various parts are assembled in either one or the other of the following manners, at the external angles. The



large surfaces are either put together with straight joints, which are *keyed* at the back, that is, bound by means of a longitudinal tie; or are *clamped*, that is, let into a piece running in the same plane with the vertical boards, but in a horizontal direction; or are panelled, that is, made with stout *styles* and *rails* filled in with straight jointed boards, so that the styles and rails form raised frames above the surface of the panel face. When wall linings are executed, they are frequently made with what are called rebated and bead flush-joints  for the purpose of disguising the shrinkage of the various boards, and they finish against a beaded capping; but it is in the putting together of doors, cupboard-fronts, and shutters, that the greatest varieties of framing are admitted. Thus doors are either *plain clamped*, or they are *plain clamped and ledged* doors, when they are made with straight joint boards, clamped at the top and bottom, or when they have in addition, ledges to receive the hinges or to stiffen the work; sometimes clamped and ledged doors are executed with joints beaded on one or both sides. Panelled doors have four or six panels, as the case may be, and they are either made with the filling in parts flush with one side of the work, or sunk below the level of the framing on both sides; so that the doors are said to be either flush one or both sides, or panelled one or both sides. Again, the panels may be either *bead flush*, or *bead butt* (the former, when the beads mitre and return at the extremity of the panels, so as to make a regular frame round it; and the latter when the beads butt against the top and bottom rails); or they may be *square both sides*, or *moulded one side and square*, or *moulded both sides*, according to the mode of ornamenting the panels. Sometimes also the panels are *raised;* or they may even project beyond the face of the framing, and then become *bolection* panels. All these doors are fixed either in solid frames, or upon framed grounds and jamb linings, with the necessary architrave mouldings.

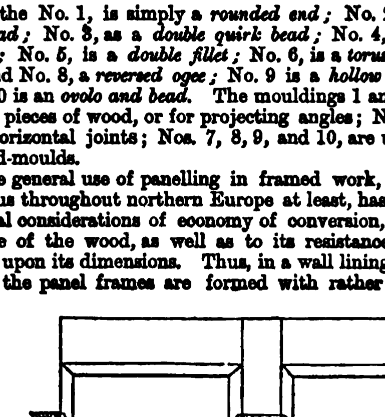
Windows are either made with fixed sashes in solid frames, and with two or more panes of glass carried by sash-bars. If the windows should be made to open, by rising or falling vertically, they are called single or double hung sashes, as the case may be; if they open on hinges, they are called *pivot sashes*, when they simply revolve on horizontal or vertical pivots; or *casement sashes*, in one or two leaves, when they open on vertical hinges fixed to the sides of the frames. The frames themselves are either *solid* for pivot or casement sashes, or they are *boxed frames*, for single or double hung sashes; and the latter are made with outside beads, parting beads, parting slips, axle pulleys, lines and counter weights as may be required. Shutters are either made to slide into boxes placed in the window backs, and placed under the level of the window-cills, or they are made to close into boxes, either splayed or square, from the frames; and they may be in one or more leaves as may be required, in order to avoid needlessly projecting into the room. External shutters and sunblinds are, in fact, modifications of internal shutters, and are sufficiently well known to allow of their being passed over without any detailed description. With regard to cupboards, counters, shop fronts, dressers, drawers, and the other countless details of house finishing which enter into the province of the joiner, it may also suffice to say, that the principles of their framing are so closely allied to those involved in the execution of doors and sashes, wall linings, &c., above described, that they may be summarily disposed of, by saying that the general conditions all such works should fulfil, should be that the wood of which they are made should not be exposed to shrink, and that the various parts which are intended to move, should be able to do so freely and easily. The various works in question may be executed in solid wood, or in wood *veneered*, or covered by a thin sheet of some more valuable description of wood glued to the exposed face of the commoner one serving as the substructure; and in such cases as the execution of columns, rounded corners, circular niches, &c., narrow pieces of wood are put together with glue, and blocked or keyed at the back.

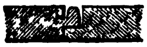
The mouldings most commonly used in joiner's work are as follows:



Of these, the No. 1, is simply a *rounded end;* No. 2, is known as a *quirked bead;* No. 3, as a *double quirk bead;* No. 4, is a *double bead and quirk;* No. 5, is a *double fillet;* No. 6, is a *torus bead;* No. 7, is an *ogee*, and No. 8, a *reversed ogee;* No. 9 is a *hollow and half round;* and No. 10 is an *ovolo and bead*. The mouldings 1 and 3, are used for projecting pieces of wood, or for projecting angles; Nos. 2, 4, 5, 6, are used for horizontal joints; Nos. 7, 8, 9, and 10, are used for cappings or for bead-moulds.

Now the general use of panelling in framed work, which is so very conspicuous throughout northern Europe at least, has been the result of practical considerations of economy of conversion, and strength of assemblage of the wood, as well as to its resistance to atmospheric influences upon its dimensions. Thus, in a wall lining of any considerable area, the panel frames are formed with rather thicker material than might theoretically have been required, but the panels themselves are made as much thinner in proportion; and, as their surface is greater than that of the styles and rails of the framing, an economy of material is obtained. Moreover, as the direction of the grain of the wood in the various parts of the framing differs in the cases of the rails



and panels from that of the styles, the tendency of the respective parts to shrink or to warp is to some extent counteracted. Again, the heading joints of the styles and rails are made with what are called *mortice and tenon joints*, or those in which a hole of a rectangular form is cut in either the styles or rails, and into it is closely fitted a projecting tongue left on the other piece to be assembled, which is subsequently fixed by the use of glue, wedges, or pins. Before, however, the framing in this supposed case is wedged up, the panel is introduced, and fitted into grooves left in both styles and rails; and after the whole has been wedged up, a moulding is nailed to them, all round the panel, so as to allow the latter to shrink without exposing the joint. It is a similar motive to the latter which leads to the use of what are called matched and beaded linings ; for the shrinkage in the width of the planks is in them rendered less apparent by the introduction of the double quirked bead, formed by the bead on the edge of one board and the rebated joint on the other. These remarks apply also to doors; but the introduction of panels in them, and in window shutters, &c., has the additional advantage of rendering the particular articles to which they are applied actually lighter; whilst at the same time they tend to destroy the unpleasant effect of large, unmeaning, plane surfaces. The introduction of panelled work into strings of staircases seems to be very questionable, either in point of taste or of construction; and that joiner's work which is manifestly intended to resist violent actions or great weights, should be, and should look as though it were, of the most solid and substantial description.

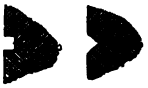
In the preparation of tanks, cisterns, vats, and other vessels intended to contain water, great attention must be paid to the manner of making the horizontal joints, which are usually formed with grooved and feather tongues, set with white lead instead of glue, and to the lateral stiffness of the sides. The principles which regulate the thickness of such vessels belong to the science of HYDRODYNAMICS.

It is essential to observe that the durability of joiner's work depends upon its being removed from sources of damp, or from confined air, especially when the latter is both warm and damp. The planks which contain any sap-wood are certain to decay with rapidity in such situations; spruce fir decays more rapidly than pine, or ordinary deal; all soft woods decay more rapidly than oak; and of oaks, those which are the hardest last the longest in damp positions; mahogany resists change of hygrometric state better than fir-woods, but not equally well with oak. Joiner's work which has been veneered is not fit to be exposed to alternations of wet and dryness; and indeed any glued work will certainly fall to pieces if kept for any time in a damp state, whilst extreme heat is equally prejudicial to it. Perhaps mahogany resists strong light and heat better than any other wood, and it is on this account much used for making shop-fronts, or for external joinery. It is also used for hand-rails of staircases in preference to all other varieties of wood, because of its markedly small tendency to break into splinters, and this fact may also account to a great extent for its use for tables or counter-tops.

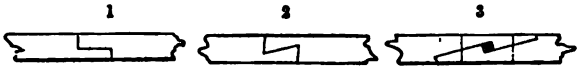
3. It is rather curious that whenever the taste or the fashion of an age has brought the art of wood-carving conspicuously into notice, the architecture of the period has begun to degenerate into a florid and rather over-ornamented style; as for instance, about the latter end of the middle ages, the taste of the wood carvers of Westphalia seems in Germany to have led to the elaborate complicated style observable in the Gothic structures of the end of the 15th and beginning of the 16th centuries; whilst the elaborate wood sculptures of the Flemish churches of the 17th century were contemporary with the introduction of a still more equivocal taste. How far the art of wood-carving has acted upon, or been reacted upon, by the taste of the age, it would be hard to say; but there certainly would appear to exist some tendency on the part of those who work in a material so easily made to yield to the artist's fancy as wood certainly is, to indulge in the display of their imagination, and of their own manual dexterity; and this tendency has on some occasions proved to be so overpowering that it becomes almost necessary to recall the attention of the workers in wood to the necessity for their studying the abstract laws of beauty as applied to art structures. Even in the case of common joiners, there seems to be somewhat of the tendency to transfer to other arts the modes of thought suggested by the practice of their own; and we consequently find that the architecture known as "carpenter's architecture" is marked by the panelling of all plain surfaces, and an unaccountable introduction of beads, toruses, and ogees. The laws of taste applicable to one art, in fact, are rarely applicable to others; and those applicable to joinery are of so narrow and so limited a character as to lead to very ridiculous results if extended beyond their proper sphere.

It seems, indeed, that beyond the mere questions connected with the colour and grain of the woods employed (so far as they influence the style of decoration), the principal laws of taste in the use of joiner's work are that, 1st, no ornaments should be introduced, or no mode of assembling the framing be adopted, which should appear to weaken the strength of the work, or to bring efforts upon it in directions wherein the wood would be the most likely to yield; 2nd, that no attempts should be made to represent in joiner's work methods of construction exclusively applicable to other materials; 3rd, that the harmonic proportions of panels, or other framed joiner's work, be rigorously observed. All questions of detail must of course be made subservient to the general design; and, in the latter, care should be taken not to bring the works of one set of artisans too strongly into prominence.

JOINT. In constructive operations the word *joint* is used to express the means adopted to ensure a greater length in any part of the work than can be obtained by the use of the natural materials, or to form large masses of work; or to enable one part of the work to turn upon another, in the manner of a door, casement, &c. The different kinds of joints of the first description assume names dependent upon their forms, positions, and the materials in which they are executed; and the joints of the second description assume names dependent upon the manner and extent of opening they are intended to secure.

Thus, in masonry and brick-work, the sides, or vertical faces of the materials within the face of the walls, are called *joints*, in contradistinction to the horizontal faces or *beds;* and they are called either *heading* or *stretching*-joints, as they may be laid with their shorter or longer dimensions in the same direction as the face. They may be perpendicular to the face or dovetailed, as in the courses of the Eddystone Lighthouse; and in arches they are made normally to the curve of the intrados; in ornamental work they are sometimes *rusticated*, or made either with a species of sunk rebate or with splays on the edges, thus:  and they are either (in ashlar masonry) *cramped* on the top, *dowelled*, or made with a *joggle* thus: this form of joint is used for landings of staircases. When straight architraves are carried over wide openings, it is customary to form in them what are called *concealed arch-joints;* a very vicious style of construction, it may be added.

The various descriptions of joints used in timber-work differ from those of masonry and brick-work, in this respect: that they are expressly made for the purpose of lengthening the several pieces of wood, rather than of enabling them to form parts of a structure, whose stability should consist in the reaction of the laws of gravity, on the materials employed, upon those materials themselves, as in the case of stone and brick-structures. The joints of wood work then are:—No. 1, the *lap-joint*, in which one piece of timber is cut out so as to allow the other to fit over it and to be fastened simply by nailing. No. 2, the *dove-tailed lap-joint*, in which the faces of the laps are cut with an inclination from one another, so as to offer a resistance to the lateral displacement of the timber; and this object is more effectually attained by the *scarf-joint*, No. 3, especially when it is (as in the sketch) keyed and wedged. In certain positions, as in tie-beams of long span, the scarf-joints, instead of being made horizontally, are made vertically; but, in all such works it is customary to stiffen them by means of bolts and of plates of wrought-iron, on either side of the scarf. In joiner's work, *lap-joints*, *grooved* and *tongued-joints*, *tenon-joints* and *splayed-headings* are used, for a description of which see JOINERY.



In metal works, joints are sometimes lapped, dovetailed, and scarfed, as in carpentry; but they are also either *welded*, *brazed*, or *soldered*, according to the nature of the metal and of the purposes intended to be effected. *Welding* consists simply in bringing the ends of the metal to such a heat, as to allow the percussion exercised upon them, when in that state, to effect a complete homogeneous junction of the respective ends—to make the lengthened bar, in fact, precisely analogous in its powers of resistance to longitudinal strains to those of the original bars. *Brazed joints* are those made when edges of iron, copper, brass, &c., are run together by means of an alloy consisting of brass and zinc, with occasionally small proportions of tin and silver. SOLDERED JOINTS are very nearly the same as brazed joints, or they are those made when surfaces of metal are united by means of a more easily fusible material, which is run between the said surfaces, and binds them together by chemical and cohesive force; and thus according as the metal surfaces are similar or different, it becomes necessary to vary the nature of the solder to be used. The most important observation to be made with respect to the execution of either of these fused joints is, that it is essential to keep the faces of contact perfectly bright, and free from any kind of dirt or extraneous bodies. In metal work, rivet joints are also used.

The hinge joints used in joiner's or smith's work, are of an almost endless variety, but in common practice they may be said to be comprised under the following principal varieties. The *butt joints* are those in which the hinge is made to bear a rounded edge, for the purpose of carrying on the line of a bead worked on the edge of the frame, designedly to hide the mode of hanging; sometimes, however, the butts are made to project when the door, casement, flap, &c., may be required to fold back over a projection. A description of hinge joint, called a *back flap*, is sometimes used in common work, for the same purpose as butt hinges; and when the development of the door is very considerable, the joint is made with what are called *pulpit hinges*. *Rule joints* are used when the doors or windows require to open back to great distances; that is to say, when the centres of motion are situated at distant points from the plane of the closed door or window; *quadrant joints* are sometimes used for this purpose, but they are identical in principle with rule joints. Pivot joints, and swing centres are those used when the doors and windows are made to revolve on fixed points, placed either vertically or horizontally, either within or beyond the plane of the closed work. The objects to be attained in any of these descriptions of hinge joints are, that the various articles to be moved should be able to do so easily, and without friction or noise; and that they should shut close, so as to prevent air or dust from passing through.

In the enclosures of railway sheds or in waiting-rooms of railway stations, a description of joint, known as a *sliding joint*, is used, in which the doors are carried upon rollers that run upon a rail, above or below the door; and in modern shops the external shutters are made with what are called *revolving joints*, or they are made to wind round a horizontal or vertical bar, upon a species of tambour frame. It may also be desirable here to add, that in pipe laying, the joints are either made with a *spigot and faucit*, in which the end of one pipe fits into a socket cast on the end of the other, and is rendered steam- water- or gas-tight, by the yarn, whitelead, or melted lead run into the interval; or they are made with *flanges* or broad faces made to bear closely against one another, either with a turned face, or by the interposition of some elastic substances.

JOINT-STOCK COMPANIES. These Companies are distinguished from other Corporations by being associated, not for any public or administrative purpose merely, but for carrying on a trade or business with a view to individual profit. They possess other peculiarities equally deserving of notice.

This system of association, which has received such gigantic development in modern times, is by no means of recent origin. Institutions founded on the same principle as the trading guilds of the middle ages seem to have existed among the Saxons; and soon after the conquest we find companies of different trades established in the various seaports and other towns of importance in the kingdom. These fraternities generally became in course of time chartered corporations; each possessing the exclusive privilege of following the particular occupation which it professed to protect. After the Reformation they mostly became merged in the municipal corporations, the franchises of which could in many cases be enjoyed by those only who were *free* of one of the companies into which the community was divided. In this position they remained until the Municipal Corporation Reform Act. Besides these guilds, or companies, other trading associations sprung up from time to time. The general company of Germans, called also the Merchants of the Hanse, dates from 1220, and became in the 15th century the Company of the Steelyard. In 1505, the "Merchant Adventurers of England, for trading in woollen cloths to the Netherlands," obtained a charter of incorporation, prohibiting the Hanse merchants from interfering with them, and the Steelyard Company seems thereafter to have gradually declined. In 1553, was established the company of "Merchant Adventurers for the discovery of lands, countries, isles, &c., not before known by the English," which resulted in the establishment of a trade with Russia. The Turkey Company, the African Company, the Eastland Company, the East India Company, were all chartered monopolies; but the Hudson's Bay Company alone remains on this ancient footing.

Soon after the Revolution, the principle of association began to be applied to a variety of purposes besides those of foreign adventure. Numerous projects were started, the execution of which could not be compassed by private means, but which it was thought might be attained by raising capital on the joint-stock principle. Hence arose, in the early part of the 18th century, the speculative mania, remembered in connection with the famous South Sea Company; of which we have seen counterparts more than once in our own times. To meet the evils occasioned by this novel development of the associative tendency, the "Bubble Act" (6 Geo. I. c. 18), was passed, declaring all companies which presumed to act as corporate bodies, and to pretend to raise transferable stock, public nuisances, and the promoters of them punishable accordingly. This statute was directed not so much against the offence of acting as a corporation without authority, as with a view to prevent the frauds of unprincipled adventurers, who proposed schemes merely as baits to extract money out of the pockets of the thoughtless. Such an object, however, is not to be effected by mere legislation. The gambling in stocks and shares which seems to be periodically revived among us, and which, in 1719, produced the "Bubble Act," came to an end during the crash following the wild speculation which led to the statute; but the Act, nevertheless, had some effect in restraining for the future projects of a similar character to those against which its provisions were directed.

During the last century a large number of useful public undertakings, such as the making of canals, bridges, harbours, docks, and the like, have been carried into effect by companies formed on the joint-stock principle, and incorporated by Acts of Parliament; and more recently our gigantic system of intercommunication by railway has been obtained in a similar way. In these undertakings, the assistance of the legislature was necessary, not so much to give a corporate existence to an association of capitalists, as to enable the company to carry out its project by the compulsory purchase of property, and to make by-laws binding on the public for protecting the rights of the corporation. These companies, like the old trading associations, partake of the advantages derived from incorporation; advantages in which mere associations of individuals joined together to promote such common objects cannot possibly participate. A mere assemblage of adventurers cannot, for instance, by any agreement among themselves sue or be sued in the name of any one of their body, or of any officer they may select for the purpose; they are liable, on the contrary, to the same laws as ordinary partnerships, and each individual is responsible to his last shilling for the acts and omissions, the contracts and debts, of the body generally. To facilitate the operations of such associations, various statutes have been passed; but owing to the fluctuation in opinion regarding the true policy to be pursued, the legislation relating to them has not been altogether consistent.

The original mode of forming a joint-stock company was by means of a deed of settlement, which constituted trustees of the partnership property, directors of its affairs, auditors of its accounts, and other officers, defined the number of shares into which the capital was divided, and the form and mode of transferring them, and laid down rules for periodical meetings of the shareholders. In the absence of legislative interference, the rights and liabilities of the members of such bodies, in relation to the public, were the same as those of other members of ordinary partnerships; their rights and liabilities *inter se* depended on the provisions of the deed of settlement. The difficulties which were soon found to arise, in carrying on the business of such undertakings, induced the earlier joint-stock companies to obtain private Acts of Parliament, which usually enabled the company to sue and be sued in the name of the secretary or some public officer appointed for the purpose, and almost invariably concluded with a proviso that nothing therein should tend to *incorporate* the partnership; for one effect of incorporation would have been to destroy the individual responsibility of the members for the acts of the association, which the legislature, until quite recently, most carefully retained. As joint-stock companies, however, increased in number and in usefulness, the cost and trouble necessary to obtain a private Act of Parliament were felt to be extremely burdensome; and the attention of parliament being called to the subject, it was thought expedient by the legislature to empower the crown to grant to joint-stock companies such powers as were likely to be most useful to them, without, however, conferring all the incidents of a corporation. The first attempt at legislation in this direction was the statute 6 Geo. IV. c. 91, which enabled the crown, in any charter of incorporation thereafter to be granted, to provide that the members should be individually liable for the debts and engagements of the corporation. This act proving inoperative, another mode of proceeding was tried by 4 & 5 Wm. IV. c. 94, which enabled the crown to grant to joint-stock companies the privilege of suing and being sued in the name of any of their officers. This act was soon repealed, and another attempt made in the same direction by 7 Wm. IV. and 1 Vict. c. 73. At length the 7 & 8 Vict. c. 110 was passed, for the registration, incorporation, and regulation of all future joint-stock companies not requiring nor obtaining a charter or act of parliament. This statute introduced a system of public *registration*, by which the company became *incorporated*, for the purpose of carrying on the business for which it was formed, according to the provisions of its deed of settlement; but every shareholder remained liable individually for the debts and contracts of the company, and might be proceeded against as though he were not a member of the corporation. Banking companies were excepted from this statute, the 7 & 8 Vict. c. 113 being passed for their special regulation.

A great many joint-stock companies were formed, and by registration obtained the corporate privileges, which they were now enabled to do; but before long the affairs of several became involved, and the difficulties which then presented themselves in attempting to adjust the rights and liabilities of the shareholders led to the Winding-up Acts, 11 & 12 Vict. c. 45, and 12 & 13 Vict. c. 108, which for several years exercised the acumen of the judges of the Court of Chancery, in a series of hopeless attempts to interpret and follow out their provisions. The effect of the litigation carried on under these Acts was to throw a very strong light upon the principles of legislation applicable to joint-stock companies; and the knowledge thus purchased at an enormous expense led to the repeal of the Registration and Winding-up Acts, and to a total remodelling of the law regarding these associations. This has been effected by the statute 19 & 20 Vict. c. 47, which provides for the registration, under its own provisions, of all companies previously registered under the former statute. The Act itself has been amended by 20 & 21 Vict. c. 14.

The principle of limited liability, or the restriction of the responsibility of each member to the amount of the capital subscribed by him, which had long been conceded to companies incorporated by Act of Parliament, without baneful effects to the commonwealth, has been at length extended to all joint-stock companies coming within the operation of these Acts which choose to adopt their provisions, on the sole condition of obtaining registration and conforming to a few simple rules, whereby the personality of the company is defined. From its operation are excepted all companies established by Act of Parliament, royal charter, or letters patent, all banking or insurance companies, and associations engaged in mining in the Stannaries, where companies with a limited liability may be formed conformably to certain local customs, which are generally known as the *Cost-Book System*.

There now exist, therefore, four classes of joint-stock companies.

1. Trading companies incorporated by special Acts of Parliament. This class includes railway, dock, harbour, and canal companies, many insurance companies, and a vast number of other bodies engaged in every species of profitable employment. Formerly each company thus incorporated was governed by the peculiar provisions of the Act which it obtained; but in order to introduce uniformity, a general Act, applying to all future companies, was passed under the title of 'The Companies' Clauses Consolidation Act,' 8 & 9 Vict. c. 16. This statute contains a complete code for the regulations of the proceedings, the transfer of the shares, and the general management of companies incorporated by Act of Parliament. 'The Lands' Clauses Consolidation Act,' 1845, was passed at the same time, consolidating all those provisions which it had previously been necessary to insert in the special Act of any company, which required powers of acquiring land compulsorily for the purposes of the undertaking.

The peculiar character of railway undertakings rendered necessary 'The Railways' Clauses Consolidation Act,' 1845, which lays down regulations as to the construction of railway works, the amount and mode of enforcing the payment of tolls and fares, and the making of by-laws for the conduct of their business, which are binding upon all persons whatsoever.

2. A second class of joint-stock companies consists of the very few established under the statute 1 Vict. c. 73, or the preceding Act, 6 Geo. IV. c. 91, which have been already referred to.

3. Banking companies formed since 1844 form a distinct class. They were until recently regulated by the statute 7 & 8 Vict. c. 113, but must now be registered under 'The Joint-Stock Banking Companies' Act,' 1857, which preserves the individual liability of the partners, and contains provisions for the company being wound up. Banking companies constituted previous to 1844 may avail themselves of the advantages of the statute, by being registered under its provisions.

4. The last class of trading corporations are the registered joint-stock companies, regulated by the Joint-Stock Companies' Acts, 1856 and 1857, under which seven or more persons may, by subscribing a memorandum of association, and otherwise complying with the requisitions of the statute in respect of registration, form themselves into an incorporated company, with or without limited liability.

This registration is obtained by delivering to the registrar of joint-stock companies a memorandum of association, stating certain particulars in a prescribed form. Upon registration being effected, the subscribers, together with such persons as from time to time are admitted to be shareholders in the company, become a body corporate, having a perpetual succession and a common seal, and power to hold lands to a certain extent, and with consent of the Board of Trade to any extent whatever.

The company may hold itself forth to the public as one of which the members are liable with or without limit, according as the founders of it choose to adopt the principle of limited liability or not. Where the liability of the shareholders is limited by the memorandum of association, the word "*limited*" must be the last in the registered title of the company, and must be inseparably attached to its name.

The statute requires that a register of shareholders shall be kept, and that this list be annually revised, and a copy furnished to the registrar of joint-stock companies. This copy is open to public inspection, so that all the particulars of importance respecting the company can be at any time ascertained by persons dealing with it.

The affairs of a registered company are also liable to examination by the Board of Trade; while the statutes contain a complete code of regulations for winding up a company unable to meet its engagements, or which it is thought desirable to wind up for other reasons. Directors who declare a dividend when the company is insolvent are jointly and severally liable, to the extent of the dividend, for all the debts of the company; and every person concurring or carrying on the business of the company when the number of the partners is less than seven, is severally liable for its debts.

This species of corporation may be dissolved by being wound up, either voluntarily or compulsorily. A voluntary winding up may take place: 1, whenever the period, if any, fixed for the duration of the company expires, or the event, if any, occurs upon which it is to be dissolved; 2, whenever the company has passed a special resolution requiring its winding up.

A company may be wound up compulsorily: 1, by virtue of a special resolution to that effect; 2, whenever it does not commence business within a year of its incorporation, or suspends business for a year; 3, whenever the shareholders are less than seven in number; 4, whenever the company is unable to pay its debts; or, 5, whenever three-fourths of the capital have been lost or become unavailable.

A company is to be deemed unable to pay its debts: 1, whenever a creditor for 50*l.* has served a demand of payment, and the company has for three weeks neglected to pay the claim, or to secure or compound for it to the satisfaction of the creditor; and, 2, whenever an execution is returned unsatisfied, in whole or in part.

The proceedings take place in the case of companies whose liability is unlimited, in the Court of Chancery; in the case of companies with limited liability, in the Court of Bankruptcy. (Blackstone's 'Commentaries,' Mr. Kerr's edition, vol. i., p. 526.)

JOINT TENANCY signifies joint ownership of two or more persons in land, or other property, as goods and chattels. It differs from Tenancy in Common [COMMON, TENANCY IN] and Coparcenership [PARCENERS] in the following essentials: joint tenants are severally seised or possessed of the undivided whole of the land or other property in which they have a joint interest, and also of their several shares, which shares are always equal shares, inasmuch as joint tenants take by purchase only, and by a joint title: the estate or interest must be limited to the several persons by the same deed or instrument, and such estate or interest must vest in them at the same time, except (according to the more common opinion) the estate be limited to take effect under the Statute of Uses or by devise, in which cases the contemporaneous vesting of the several parts is not necessary: the whole estate or property will go to the survivors and survivor of the joint tenants, if the jointure continue until such survivorship; which is the important characteristic of a joint tenancy. It is a consequence of the mode in which joint tenants are legally considered to be seised or possessed, and of the right to the whole which accrues to the survivors and survivor, if no separation of the joint tenancy has been made before such survivorship takes place—that they cannot grant, or bargain and sell, or surrender or devise to each other; they cannot exchange with each other, nor can one make a feoffment to another. But any joint tenant may transfer his interest to any one of his companions by release, or rather he can by such instrument put an end to his interest; and any joint tenant may convey his share to a stranger by grant; or he may compel his companions to make a partition, by statute. Every person to whom the interest of a joint tenant is transferred becomes, as to such share, a tenant in common with the remaining joint tenants.

A joint tenant cannot dispose of either the whole or the part of the property in which he is jointly interested consistently with the proper notion of a joint tenancy, by a will made during the continuance of the joint tenancy, even though he should happen to be the survivor; because until he has survived he has nothing to dispose of by will. But by severing the joint tenancy he acquires the power of disposing of his share by will. By the Wills act (1 Vict., c. 26), a person may by a will, made according to the provisions of that act, dispose of all real and personal estate to which he shall have a legal or equitable title at the time of his death, and which, if not disposed of by will, would go to his heir, or the heir of his ancestor, or to his personal representatives. But this act gives no power of disposal over the unsevered interest of a joint tenant.

As to the written instruments and words by which a joint tenancy may be created, and the various rights and remedies which belong to a joint tenant, it is not necessary to dwell at any length here. The discussion of them belongs to special treatises on law. As an example of words which would create a joint tenancy, we may take the case of a feoffment to two or more persons and their heirs, which would make the feoffees joint tenants in fee simple, so that the survivors would always succeed, and the last survivor would take the whole in fee, unless any one of the joint tenants had in his lifetime conveyed his share. And generally, when there is a gift of real or personal estate to several persons, and nothing more is said, these words make them joint tenants, even in the case of pecuniary legacies and residuary bequests. To create a tenancy in common, it is not necessary, either in a deed or will, to declare that the parties to whom the gift or devise is made shall take it as tenants in common, and not as joint tenants. Any words which undoubtedly convey this meaning are sufficient for the purpose; but less exact or definite words are required for this purpose in a will than in a deed. Where an estate is given to two persons and the heirs of their bodies, if the two persons are such as cannot have common heirs of their bodies (as two men or two women, or a man and a woman who cannot legally intermarry), then such persons are joint tenants for life, but have separate inheritances, or are tenants in common in remainder in tail. But if the gift be to a man and his wife and the heirs of their bodies, or to a man and woman who may marry and the heirs of their bodies, the parties are joint tenants of the inheritance; and if they be husband and wife they take by entireties. The tenancy by entireties is a consequence of the legal unity of husband and wife. Such tenancy exists when real estate is limited by deed or will to husband and wife jointly during their marriage for an estate of inheritance or freehold: the husband and wife possess the lands entirely as one individual; on the death of either of them they go to the survivor, and there is no power of alienation or forfeiture of either alone which can prejudice the right of the other.

Partners in trade are joint tenants of the partnership stock which is of a moveable kind, but on the death of a partner his personal representatives become tenants in common in equity, with the surviving partners; and it was at one time considered that they acquired a legal tenancy in common, with the survivor. In equity there is no survivorship in lands which partners have held for the purposes of trade.

If money is jointly advanced by two or more persons on a mortgage security, there is in equity no benefit of survivorship among them.

A joint tenant, like a tenant in common, cannot maintain an action of trover against his companion for goods which are in his companion's possession; for according to the English doctrine of possession, possession by one joint tenant, tenant in common, or parcener, is generally the possession of all. The doctrine of possession by joint tenants, tenants in common, and parceners, is materially altered as to lands and rents by 3 & 4 Will. IV., c. 27, sec. 12, and in another case by sec. 13.

JOINTURE. This legal term was originally used to denote the interest of joint tenants, which interest was called an estate *in jointure.* Before the statute of 27 Hen. VIII., c. 10 (of Uses), lands conveyed to uses were not subject to dower; and as such conveyances were frequent, it became usual to stipulate, upon a treaty for a marriage, that the intended husband should convey an adequate portion of his lands to the use of himself and wife *in jointure,* that is, as joint tenants for their lives, whereby a provision would be secured to the wife, if she survived, commensurate in point of duration with the dower which the common law would have given her, if the system of uses had remained unknown. When the Statute of Uses was passed for transferring the legal estate to the *cestui que use,* it was considered unreasonable that wives should by means of the destruction of uses be entitled to claim dower in their husbands' lands, and should at the same time enjoy a provision made for them in consideration that they were not so entitled. The sixth section of this statute therefore provided that women having provisions in the nature of jointures should not be entitled to claim dower of the residue of their husbands' lands. [Dower.]

An estate limited to a woman must, in order to be deemed a good jointure and a bar to dower under this statute, commence and take effect in possession or in profit immediately on the death of the husband. It must also be for the life of the wife, or for some greater estate. It must be in satisfaction of the whole dower, and not of a part only. It must be made before the marriage; for by the ninth section, if the jointure be made during the marriage, the wife is at liberty after the death of her husband to refuse the jointure and demand her dower. If however the widow once accept such jointure, she is perpetually bound, even though the estate in jointure created during the marriage be made subject to a condition, and is in that respect less beneficial than dower.

A woman, though under age at the time of her marriage, is bound by an antenuptial jointure, inasmuch as the bar of dower arising out of the limitation of a jointure is not a matter of contract (by which minors are not bound), but proceeds upon the ground of the substitution of a new provision made by the husband, or on his behalf, under the authority of an act of parliament. It was formerly considered that the estate must be directly limited to the wife herself, and not conveyed to others in trust for her; but it is now settled that a trust estate is a good equitable jointure in bar of dower.

Where an estate tail is limited to a woman for her jointure, she is restricted from alienation or discontinuance by 11 Hen. VII., c. 20, and 32 Hen. VIII., c. 36; on the other hand, if she be lawfully evicted from the whole or part of the jointure lands, she will be entitled to be endowed of the residue of the lands of which, but for such jointure, she would have been dowable, to the value of the lands of which she has been deprived by such eviction.

In consequence of the practical inconveniences attending a limitation of land by way of jointure, it has become usual to create a rent-charge (that is, an annuity charged upon land with a power of distress) for the life of the wife, with the power of distress, and also a power of entry, that is, the right of entering upon the land charged and retaining the possession until the annuity is paid, and further protected by a demise of the land to a trustee for a term of years. Such annuity ought in strictness to be charged upon the land which would otherwise be liable to dower, or upon some part of it.

This arrangement is equally beneficial to the widow and to the heir or devisee of the husband. A more certain income is provided for the widow, and the heir or devisee may enter into the immediate possession and take upon himself the management of the whole estate. This substituted provision by way of annuity is frequently called the wife's jointure.

(*Co.-Litt.* and Hargrave's *Notes;* Cruise's *Dig.;* Bacon's *Abr.*)

JUDAISM includes, in its most extensive signification, not only the system of religion which is believed in by the Jews, but also all those laws, moral, civil, political, and ritual, which are contained in the five books of Moses. Some of the peculiar tenets of this religion were imparted to Abraham, the ancestor of the Jewish people; but it did not receive its full development till after the departure of the Israelites from Egypt and their arrival at Mount Sinai, where the Supreme Being imparted to Moses the whole system of the Jewish economy. After the destruction of Jerusalem by the Romans, and the dispersion of the Jews over the various countries of the world, all those laws which related to government, and which could only be enforced in a country where the Jews possessed political power, necessarily became obsolete; and the term Judaism has consequently been restricted to those religious and moral laws which are contained in the Pentateuch, or which have been adopted or retained from tradition, or by inculcation of their rabbis, and which are recognised by the Jews to the present time as the rule of their faith and conduct.

An interesting account of the ceremonial rites and religious and philosophical opinions of the modern Jews (that is, of those who lived during and subsequently to the time of Christ) is given in Allen's 'Modern Judaism,' 1816.

JUDEX, JUDI'CIUM. It is of some importance to form a correct notion of the terms *judex* and *judicium* in the Roman writers. The *Judicia* were of two kinds, *privata* and *publica;* the former, having relation to *actiones,* may be generally described as civil actions; the latter were of the nature of criminal prosecutions.

In the Judicia Privata the party complainant (*actor*) came before the prætor or other magistrate who had jurisdiction (*jurisdictio*), and made his claim or complaint, to which the defendant (*reus*) might put in a plea (*exceptio*). The prætor then made an order by which he referred the matter to Judices, or Recuperatores, or Arbitri, whose chief office was to ascertain the facts in dispute. The formula, or order of the prætor, was of the nature of a provisional decree: it stated the matter at issue between the parties, and the judgment that was to follow upon the determination of the facts. The plaintiff had to prove his case, or the defendant to prove his plea, before the judices. Sometimes there was only one judex. The speech of Cicero 'Pro Publio Quintio' was made before a single judex, aided by assessors (*consilium.*)

The patroni or orators appeared before the judices to support the cause of their clients. The judices were sworn to act impartially. Witnesses were produced on each side, and examined orally; and it is clear from the remarks of Cicero ('Pro Cæcina,' c. 10), where he is commenting on the evidence in the case of Cæcina, that he had cross-examined and put to confusion an impudent witness on the other side (see also the oration 'Pro Flacco,' c. 10). It is clear also from the oration 'Pro Cæcina,' that the inquiry before the judices was public. Written documents, such as letters and books of accounts, were produced before the judices by way of evidence. (Cicero, 'Pro Q. Roscio.') When the orators had finished their speeches, the judices decided by a majority. The form in which the judices pronounced their decision was that of a judgment or decree.

The difference between the judicium and arbitrium was this: in the judicium, the claim, demand, or damages, was a sum fixed; in the arbitrium it was a sum uncertain; and this difference was attended with certain variations in the procedure. This is very clearly expressed by Cicero ('Pro Q. Roscio,' c. 4).

The judices were allowed to have assessors (*consilium*) learned in the law (*juris-consulti*), but they merely advised the judices, who alone delivered the decision. In case of doubt as to the law, the judices might consult the magistrate under whom they were acting; but as to the matters of fact, the judices were the sole judges, and could take no advice from the magistrate ('Dig.,' v. 1, 79). Gellius (xiv. 2) gives an amusing account of the difficulty which he felt on being appointed a judex, and how he got rid of the business by declaring on oath, as the judex always might do, that he could not come to any decision.

We may presume that the judices were generally persons qualified by a sufficient education, though they were not necessarily lawyers; but it does not appear that they were named out of any determinate class, and there is good reason for thinking that both parties generally agreed upon the judices, or at least had the power of rejecting them. It would seem as if every Roman citizen was considered competent to discharge the functions of a judex in civil actions, at least under the emperors: but this part of the subject is not free from difficulty.

Appeals from the decisions of the judices were not uncommon. (Ulpian, 'Dig.,' xlix. 1, 1; Scævola, 'Dig,' xlix. 1, 28.)

So far seems pretty well ascertained. Such being the qualifications of the judices, and the magistrates who had *jurisdictio* being only annual functionaries, it appears that there was no class of men among the Romans, like our judges, who were the living interpreters of law for a series of years in succession. The juris-consulti seem to have kept the Roman law together as a coherent body, and it is from their writings alone that the 'Digest' is compiled. [Justinian's Legislation.]

A court is often mentioned by the Roman writers, the origin and constitution of which, if they could be thoroughly ascertained, would throw great light on the Roman judicial system, and indeed on the Roman polity generally. We allude to the Judicium Centumvirale, which in the earlier times of the Republic was a court in which weighty matters of law were decided. This court gradually declined, but was restored by Augustus. The author of the dialogue 'De Causis Corruptæ Eloquentiæ' speaks of it as most flourishing in his time; but he proves its former decay by observing that there was not a single speech then extant made by any great orator before this court, except one which he mentions. Yet both L. Crassus and Q. Scaevola had pleaded before the Centumviri. (Cic., 'De Orat.,' i. 39.) The origin, number, and constitution of this body are not known, though some writers say that the number was 105, three being chosen from each tribe. (Festus, *v.* 'Centumviralia.') But there were not thirty-five tribes till A.U.C. 513, and therefore it might be inferred that the Centumviral body was of comparatively recent date. However, this does not necessarily follow from the words of Festus; and besides, such an explanation may be nothing more than his attempt to assign the origin of the court, without being able to trace it historically. The Centumviri were not *magistratus,* but a college of *judices,* who decided in Judicia Privata. The matters which came before them were only *actiones in rem,* or *vindicationes,* not *actiones in personam,* or actions founded on contracts or delicts: consequently the matters brought before them were actions affecting ownership, servitutes (easements), wills, and intestacies. (Cicero, 'De Oratore,' i. 38, 39.) The Querela Inofficiosi Testamenti seems to have come before this court only. So far as is here stated seems to be pretty clearly made out. A valuable essay on this subject by Hollweg will give further information, and to this work, Tigerström's essay, 'De Judicibus apud Romanos,' Zimmern's 'Röm. Civilist. Process:' and Muhlenbrüch's notes to Heineccius's 'Antiq. Rom.' lib. iv. tit. vi., we refer the student.

It is not our purpose to treat at length of the Judicia Publica. They were in the nature of criminal prosecutions, in which any person, not disqualified, might be the prosecutor, and in which the verdict was followed by a legal punishment. Judices were employed here also, and were a kind of assessors to the magistrate, or the Judex Quæstionis, who presided. Both the accuser and the accused, as it seems, might challenge a certain number of the judices. Witnesses were examined before them: slaves by torture, freemen orally. The judices, at least in the more important matters, voted by ballot: each judex put into the urn the tablet of Acquittal, of Condemnation, or the tablet N. L. (*non liquet*, "it is not clear"), according to his pleasure. The magistrate pronounced the verdict according to the tablets which made a majority. A lively picture of the intrigues and bribery which were not unusual on such trials is given by Cicero in speaking of the affair of Clodius and the Bona Dea ('Ep. ad Attic.,' i. 13, 16). The various changes made as to the body from which the judices were chosen appear to refer only to the judicia publica. [Equites.]

There is a distinction between judicia publica, judicia popularis, judicia extraordinaria, and judicia populi.

The title "De Officio Judicis" in the 'Institutes' (iv. 17) contains merely general directions for the conduct of the judices.

It should be observed that this subject is not free from difficulty. What is above stated must be taken only as correct in the main features. Further inquiry is still wanted on several matters connected with the functions of the judices. Enough has been said to enable the reader to compare the Roman judices with the modern jury, and to show the difference of the institutions.

(Gaius, lib. iv.; Heineccius, *Syntagma, &c.*, by Muhlenbrüch (1841); Unterholzner, *Ueber die Rede Cicero für den Schauspieler Roscius, Zeitschrift, &c.*, i. 248; and his remarks on the difference between the *condictio* and the *actio in personam*, with reference to the *judices*; and Heffter, *Comment. in Gaii librum quartum*, D. 5, 1. D. 48. *Inst.* 4, 18.) [Interdict.]

Dr. Pettingall's 'Enquiry into the Use and Practice of Juries among the Greeks and Romans,' London, 1769, may be consulted as to the functions of the Roman judices in the Judicia Publica. The author's conclusions seem in the main to be correct, though his essay is an ill-arranged and unmethodical production. The 'Attische Process,' by Meier and Schömann, and the essay of Pettingall, may be consulted with reference to the functions of the Attic Dicastæ.

JUDGE (from the French *juge*, which is from the Latin *judex*), is a man who presides in a court duly constituted, declares the law in all matters that are tried before him, and pronounces the sentence or judgment of the law. There are judges of the three Superior Courts of Law at Westminster, judges in the Courts of Equity, judges in the Ecclesiastical and Admiralty Courts, and in the County and other courts. Some judges are called recorders, and there are other names, but the name does not alter the nature of the office. When "the judges" simply are spoken of, the judges of the superior courts of common law are meant.

The judges of the superior courts are appointed by the crown. They hold their office during good behaviour, and can only be removed by the crown on the address of both houses of parliament (13 Wm. III. c. 2). Formerly their commissions ceased upon the demise of the crown, but by the 1 Geo. III. c. 23, they continue to hold their office during good behaviour notwithstanding any demise of the crown, and their salaries are secured to them so long as they hold their office.

By various acts of parliament retiring pensions of a determinate amount may be granted to the judges of the superior courts of law, and to the judges in equity. But to be entitled to the pension the judge must have held the office for fifteen years, unless bad health has prevented them from holding office so long.

Judges of courts of record [Courts] are not liable to prosecution for anything done by them as judges. Nor are they liable to an action for any error in judgment or for wrongful imprisonment, at least when they are acting within their jurisdiction. Judges are punishable for bribery, by loss of office, fine, and imprisonment.

The powers and duties of judges would form the subject of an elaborate treatise. It may be sufficient to observe that in England the judges of the superior courts are so well protected in the discharge of their duty and so sure in their office, as to make them entirely independent of all political and private influence, and they are paid well enough to secure them against all temptation of lucre. Accordingly an instance of misconduct in any judge of the superior courts of law, or any judge who holds a high office, is now seldom or never heard of. The only question that can be raised is, whether the most competent persons are always appointed, and whether persons are not sometimes appointed who, though not absolutely incompetent, are much less competent than others, and sometimes hardly competent. The danger is somewhat lessened by the operation of public opinion, and also of the opinion of the bar, so that the risk of a totally incompetent person being appointed is not great. The press in this way exercises a wholesome but by no means sufficient check on the Lord Chancellor, by whom nearly all the judges are now appointed. It would be impossible, notwithstanding any burst of public or professional complaint, for any chancellor, however much he might wish to shape his conduct to gain public approbation, to recal an appointment, and a judge, once in office, could not well, by resigning, admit the justice of the animadversions made on his appointment. The evil thus necessarily incident to the possession of unlimited patronage by the chancellor, and to which public attention has been recently called, is inseparable from the practical working of the constitution, and is probably a much less evil than any other mode of appointment that could be suggested.

JUDGES, THE BOOK OF (שֹׁפְטִים: κριταί, Acts xiii. 20), a book of the Old Testament, which gives an account of the history of the Israelites from the death of Joshua to that of Samson. Joshua did not exterminate according to divine commandment all the nations of Canaan, but allowed each tribe to settle in the district of land allotted to it before the termination of the war. Since the tribes were not united by any national league, and were surrounded by powerful enemies, they were frequently conquered by the neighbouring nations and obliged to pay tribute. But they seldom remained in subjection for any length of time; they still retained much of the valour by which they were originally distinguished; and their patriotic efforts were usually directed or supported by a series of individuals, who were remarkable either for craft, bodily strength, or daring valour. These persons were called *Shophetim*, which is not very well translated by our English word "Judges," since, with the exception of Deborah (Judges, iv. 4, 5), none of them appeared to have exercised the judicial office till the time of Eli, who was also high-priest. After they had delivered their countrymen from their oppressors, they usually retired into private life. (Judges, viii. 23, 29.) The word would be better translated Governors, or Rulers. The most prominent duty of Oriental rulers is to be judges. The Carthaginians called their non-regal governors by the same title, modified by the Latins into *Suffete*.

The book of Joshua consists of two distinct parts. The first, after an introduction on the state of the Israelites after the death of Joshua (ch. i. ii.), gives an account of the exploits of the different judges from Othniel to Samson (ch. iii.–xvi.) There were thirteen judges, excluding Abimelech, who was made king by the men of Shechem (ix. 6), namely: Othniel (iii. 9); Ehud (iii. 15); Shamgar (iii. 31); Deborah (iv. 4); Barak (iv. 6); Gideon (vi. 11); Tola (x. 1); Jair (x. 3); Jephthah (xii. 7); Ibzan (xii. 9); Elon (xii. 11); Abdon (xii. 13); Samson (xv. 20). The second part of the book (ch. xvii.–xxi.) gives an account of an idol that was worshipped first in the family of Micah (ch. xvii.), and afterwards in the tribe of Dan (ch. xviii.); and also a history of a barbarous act committed by the Benjamites of Gibeah, which led to a war between the tribe of Benjamin and all the other tribes, in which the former was nearly extirpated.

The author of the book and the time in which it was written are equally uncertain. Among the Jews there were many prophets whose names are not mentioned in Scripture, and the book was probably contributed to by more than one, though it is commonly ascribed to Samuel. Some have argued, from Judg. xviii. 30, that it could not have been written till the time of the Babylonish captivity; but, comparing this passage with 1 Sam. iv. 11, and Psalm lxviii. 60, 61, it is most likely that it refers only to the captivity of the Ark, and of a part of the tribe of Dan, who were subjected to the Philistines. The last five chapters, also, are clearly supplementary, and were probably added about the time of Solomon. The book does not give a continuous history of the people, and contains many things which could hardly have been written by the same individual. Many of its narratives are repeated in other books of the Old Testament. Compare Judg. iv, 2, vi. 14, xi. 2, with 1 Sam. xii. 9–12; Judg. ix. 53, with 2 Sam. xi. 21; Judg. vii. 21, with Is. ix. 4; Judg. vii. 25, with Ps. lxxxiii. 11. Two or three verses in the song of Deborah are copied almost word for word in some of the Psalms. Compare Ps. lxviii. 8, 9, xcvii. 5, with Judg. v. 4, 5.

The chronology of this book has occasioned considerable difficulty. The period of the Judges is usually estimated at 299 years, in consequence of a passage in the book of Kings (1 Kings vi. 1), in which it is said that 480 years elapsed from the departure of the Israelites from Egypt to the foundation of the Temple by Solomon; though the ancient versions are not all agreed, and the present Septuagint has 440 years. St. Paul, on the contrary, gives 450 years as the period of the Judges. (Acts, xiii. 20.)

The canonical authority of this book has never been disputed. It is placed in all the Hebrew manuscripts immediately after the book of Joshua. It is quoted by Philo and Josephus, and also in Acts, xxxii. 20, and in the Epistle to the Hebrews, xi. 32.

(The *Introductions* of Eichhorn, Jahn, De Wette, Augusti, and Horne; Harenberg, *Einleitung in das Buch der Richter*; Studer, *Das Buch der Richter, grammatisch und historisch erklärt*, 1835.)

JUDGMENT is the sentence of the law pronounced by the court upon the matter in the record, and the remedy prescribed by law for the redress or punishment of injuries; the suit or prosecution being the vehicle by which the injury is brought before the court. Judgments are given under four heads of issues: on Demurrer, where the facts are confessed by the parties, and the law determined by the court; on Verdict, where the law is admitted and the fact disputed; by Confession or Default, where the defendant admits both the law and the fact; and on Nonsuit or Retraxit, where the plaintiff acknowledges that neither the law nor the facts are sufficient to support his case, and therefore abandons the prosecution.

Judgments are either interlocutory or final. Interlocutory judgments include all those which are given on account of the incomplete state of the case as brought before the court, and which do not go to the absolute merits of the case: such as judgments on pleas of abatement. But the largest class to which this term is applied are judgments which, although they decide the right between the parties, require some other proceeding to determine the amount to be recovered. This proceeding is commonly a writ of inquiry, directed to the sheriff, who therefore impannels a jury, and proceeds to assess the amount of damages to which the party in whose favour the interlocutory judgment has been given is entitled. If, however, the suit is for a specific thing or sum, the decision of the court determining whether the plaintiff is or is not entitled to recover the remedy he sues for, the judgment is final.

By the Common Law Procedure Act, 1852, a plaintiff or defendant having obtained a verdict, judgment may be signed thereon in fourteen days unless otherwise ordered by the judge. The opposite party may prevent judgment from being signed by moving the court for a new trial in case of any objection to the proceedings; for arrest of judgment, if anything bad appears on the record; for judgment *non obstante veredicto*, that is, that judgment may be given in his favour, notwithstanding the verdict, when the plaintiff conceives that a plea of confession and avoidance in which a verdict has been given for the defendant is improper; for repleader, when the pleading failed to raise the material question; or for a writ of *venire facias de novo*, when some form, as by improperly choosing the jury, has been violated. After the expiration of these fourteen days, the plaintiff or defendant may obtain the signature or allowance of the proper officer of the court, stating that the judgment is in his favour. This is called signing judgment.

The nature or form of the judgment varies according to the nature of the action, the plea, the issue, and the manner and result of the decision.

1st. If the issue be for the plaintiff.

If it be an issue at law arising upon a dilatory plea, the judgment is, that the defendant answer over, and is called a *respondeat ouster*. Upon all other issues in law, and generally in fact, the judgment is that the plaintiff do recover, which is called *quod recuperet*.

2nd. If the issue be for the defendant.

The issue being on a dilatory plea, whether of law or fact, the judgment is, that the writ or declaration be quashed or the suit be abated; if the issue be on a peremptory plea, the judgment is that the plaintiff take nothing, which is called a judgment *nil capiat*. When judgments are given by default, or confession without issue, if for the plaintiff, they are *quod recuperet*, if for the defendant, *nil capiat*.

Besides the question at issue being decided by the judgment, the costs of the suit are generally directed to be taxed and paid by the party against whom the judgment is delivered. In addition to this, the judgment, when given for the plaintiff, orders that the defendant "be in mercy,"—that is, amerced or fined for his delay of justice; and when for the defendant, that the plaintiff "be in mercy" for his false claim.

Judgment being signed, the party in whose favour it is given may sue out execution thereon, directed to the sheriff of the county where the property to be taken is situated. At common law, the goods and chattels of a debtor under a writ of *fieri facias*, and the growing profits of the land under a *levari facias*, could alone be taken in execution by a judgment creditor for debt or damages. The remedy was extended by the 13 Edw. I. stat. 1, c. 18 (West. 2), to the creditor over a moiety of the real property of the debtor, for which purpose a writ called an *elegit* was created, including all freehold estates and interests which the debtor held in severalty, coparcenery, or in common, and all rent charges; but copyholds were held not to be liable to be taken in execution under this writ. By a fiction of the law, judgments were considered to take effect from the first day of the term in which they were signed, and therefore a purchaser might have his estate encumbered by a judgment acknowledged subsequently to the purchase. To remedy this injustice, it was enacted by the Statute of Frauds (29 Car. II. c. 3), that any judge who should sign judgments, should at the time of signing set down the exact date thereof, which date should be also written on the margin of the record when the judgment was entered, and such judgments should operate from the date appearing on the margin. As, however, this did not compel the plaintiff to bring in the judgment roll, it was almost impossible for purchasers to discover what judgments existed against the lands about to be conveyed. An Act, therefore, was passed (4 & 5 Wm. & Mary, c. 20), afterwards made perpetual by the 7 & 8 Wm. III. c. 36, which directed that the clerk of the Court of C. B., the clerk of the Dockets of the Court of B. R., and the master of the office of pleas in the Court of Exchequer, should keep an alphabetical list or docket of all judgments in their respective courts, entered according to the names of the defendants; and that no judgments should affect lands in the hands of *boná fide* purchasers, unless so docketed according to the Act. How this law has been altered by recent statutes will be hereafter considered. For the purpose of discharging a judgment, the proper mode is to enter up satisfaction on the court rolls; but a deed of release will have the same effect although the judgment be allowed to remain; and it has been held that a release of all suits is a complete discharge of all unsatisfied judgments. If execution be not sued out within a year and a day of signing the judgment, it must be revived by a writ of *scire facias;* and a judgment was presumed to be satisfied after a lapse of twenty years from the signing or the last revival, which is now confirmed by the statute 3 & 4 Wm. IV. c. 27.

The entering the judgment on record, except in the cases specified by the Act, where the lands in the hands of purchasers are to be affected, is not absolutely necessary. But to support a writ even brought for the purpose of reversing the judgment, the judgment must be entered on the records of the court.

Recent statutes have introduced great changes in the law of judgments as they affect real property; but as the same rules which existed before those enactments are still under certain circumstances capable of application, it may be useful first to consider how judgments then stood.

A judgment at the time of entering up became a general lien upon all property, real and personal, which the debtor then held or subsequently acquired, and gave the creditor a legal right, so long as the judgment remained on the records of the court and unsatisfied, to enter upon and reduce into possession any such property, by suing out the writ of *fieri facias*, if the goods and chattels of the debtor were to be taken in execution, or the writ of *elegit* as to his real estate, thereby changing that which was before a naked right into an absolute interest, limited nevertheless to the amount of the debt or damages for which judgment was originally entered up.

As to personal estate, it was enacted by the 16th section of the Statute of Frauds, that the goods of the debtor should be bound by a judgment only from the time of taking out execution. And on the interpretation of this clause it was held that chattel interests in land were included under the term goods. This clause still remains in full effect, although in the case of a fraudulent assignment after entering up judgment and before execution, a court of equity would assist the judgment creditor to follow the goods into the hands of the assignee.

The rights of the judgment creditor existing only at law over the personal property of the debtor, which was afterwards extended to a moiety of the real estate, at law the legal estate was only affected, and therefore, by the subsequent creation of trusts, the judgment creditor was frequently prevented from obtaining that remedy at law against the debtor to which he otherwise would have been entitled. To remedy this inconvenience, and enable the judgment creditor to obtain execution on the beneficial interest in any portion of the property of the debtor, it was enacted by the Statute of Frauds that execution should be delivered of all such lands, tenements, rectories, tithes, and hereditaments, as any other person or persons should be seised or possessed of, in trust for him against whom execution was so sued, like as if the debtor had been seised of such lands and of such estate as they be seised of in trust for him at the time of the execution sued. On the interpretation of this statute, it was held that an equitable interest in a term of years was not included within its limits, and only such trust estate as the debtor was interested in at the time the execution was sued out, and in which he had the sole beneficial interest. In this case the judgment creditor has no execution at law, but he might come into a court of equity and claim the same satisfaction out of the equitable interest as he would have been entitled to at law if it were legal. As however the sole right of coming into a court of equity was based on the failure of the law, it was necessary that the judgment creditor should forfeit his title to the utmost by suing out his writ of elegit before the court would listen to any application to remove the legal impediment. Upon the same principle that it assisted the creditor who had no relief at law, the court of equity did not permit a judgment against a trustee, though at law a lien upon the estate, to affect the beneficial interest of the cestui que trust.

As under the last mentioned clause of the Statute of Frauds a judgment did not affect the legal estate in the hands of the trustee, until the writ was absolutely deposited in the hands of the sheriff, a purchaser of the equitable estate without notice might by getting in the legal estate protect himself against prior judgments; but if the purchaser bought with notice of the judgment, no acquisition of the legal estate would protect him. Equities of redemption were decided to be not such trust estates as to be included by the Statute of Frauds, the debtor not having the sole beneficial interest.

In the case of lands contracted to be sold, the purchaser is relieved in equity against judgments entered up subsequently to the contract; and also where land is conveyed to trustees for sale, whose receipts are to be sufficient discharge, the purchaser will not be bound by any subsequent judgments of which he has even express notice.

Until the passing of the acts 1 & 2 Vict. c. 110, 2 & 3 Vict. c. 11, and 3 & 4 Vict. c. 82, the law of judgments remained in the main unchanged. By them decrees and orders of Courts of Equity and rules of Courts of Common Law, and orders of the Lord Chancellor in matters of bankruptcy and lunacy, are given the effect of judgments, and the security of the creditor has been extended from a moiety to the whole of the debtor's lands, including copyholds, making leaseholds bound in the same manner as freeholds. And as all lands are included by the acts, over which the debtor may have a disposing power, judgments against a tenant in tail are binding on his issue; for the tenant might at any time have barred the entail. So also were equities of redemption and trust estates, in which the debtor had only a partial interest. After passing this act a question was raised whether stock was comprised in which the debtor had only a partial interest, but this was set to rest by a clause of the second act, mentioned above, which distinctly declares that the interest of the judgment debtor, whether in possession, remainder, or reversion, in any stocks, funds, or shares, as also in the dividends and annual proceeds of such stocks, &c., is to be liable to the judgment, and that stock standing in the name of the accountant-general is to be in the same position. Money and securities for money (except where deposited in the hands of a third person as a trustee) can also be taken in execution. But the greatest alteration which recent statutes have worked is changing the effect of judgment before execution is sued out, from a general lien to a specific charge upon the "lands, tenements, rectories, advowsons, tithes, rents, and hereditaments" of which the judgment debtor may, at the time of entering up judgment, or at any time afterwards, be possessed, of any estate whatsoever, at law or in equity, or over which he may have any disposing power. All the judgments are made binding on the persons against whom they are entered up, and against all persons claiming through them, the judgment creditor being entitled to the same remedies in a court of equity as if the debtor had by writing agreed to charge the lands, &c. The creditor is not however to proceed in equity to obtain the benefit of such a charge until the expiration of one year from the time of entering up such judgment; and in case of bankruptcy, the judgment, unless entered up one year, is to give no preference to the judgment creditor beyond creditors for simple contract. A special proviso excepts purchasers, mortgagors, or creditors previous to the time when the act came into operation; and with respect to purchasers for valuable consideration without notice, the rules of equity remain unaltered.

A judgment creditor, applying now for remedy to the Court of Chancery, will not be obliged to sue out the writ of elegit, for that which is agreed to be done is considered by a Court of Equity as actually performed, and the judgment creditor has therefore, by virtue of his judgment alone, an equitable estate. If however a judgment creditor, having obtained any charge, or being entitled to the benefit of any security, should, before the property so charged or secured is converted into money and applied towards the payment of the judgment debt, cause the judgment debtor to be arrested, the benefit of such charge or security is deemed relinquished. The extent of such charge goes now to the interest at the rate of four per cent. on the judgment debt, as well as to the debt itself.

The dockets which existed since the 4 & 5 W. & M. are now finally closed, and no judgment, decree, or order, which might be registered under the 1 & 2 Vict. c. 110 (see 18 & 19 Vict. c. 15, s. 4), can affect purchasers, mortgagors, or creditors, unless and until a memorandum or minute of the judgment, &c., with the person's name against whom and the date when it was recovered, is left with the proper officer of the proper court, who is to enter the same in a book kept for the purpose, in an alphabetical order by the name of the person whose estate is to be affected. In order to keep alive old docketed judgments, it was made necessary to register them according to this provision before a certain time fixed by the act, or they would be deemed satisfied.

Under the old law a purchaser was bound by undocketed judgments of which he had notice, but it is expressly provided by the late acts that the judgment creditor shall not take advantage of the extended remedies unless the judgment be duly registered according to their provisions. The necessity for searching for judgments on the transfer of property is also greatly reduced, for the 2 & 3 Vict. c. 11, requires all judgments to be re-registered every five years from the date of the last registry, otherwise they are to be considered as void against purchasers, mortgagors, and creditors; and by the act 18 & 19 Vict. c. 15, s. 5, notice of any judgment not duly re-registered will not avail against purchasers, mortgagors, or creditors. The provisions for registration, it must however be remembered, refer to the remedies which the judgment creditor may have against purchasers for valuable consideration with notice; but as between the creditor and the debtor, or his representatives or volunteers, the judgment remains in full effect until twenty years from the time of entering up or last revival. The position in general of judgment creditors among themselves before the late acts depended on the time when they respectively sued out execution; but in a suit for the general administration of assets the judgment creditors took priority according to the time of entering up their judgments. Now as they are entitled to such remedies in equity as if the debtor had by writing charged his land, they take priority in respect of their judgments from the times of registration. It has been questioned whether a subsequent judgment creditor without notice having sued out his writ of elegit is not entitled to priority over an equitable mortgagee, but the point has been decided in favour of the latter, upon the principle, that although the judgment creditor by his writ of elegit obtained possession of the legal estate, and thereby in equity, under the ordinary rules, could claim a priority to a prior equitable incumbrance of which he had no notice, yet that the legal estate which the creditor obtains under an elegit is only such a one as the debtor himself had power to grant, and therefore liable to all prior equities. (Whitworth *v.* Gaugain, 3 Hare, 461.)

By these statutes judgments of the courts of the counties Palatine of Lancaster and Durham are to have the same effect as judgments of the superior courts of Westminster. But no judgment of those courts is to affect lands in the hands of purchasers, mortgagors, or creditors, unless a memorandum of such judgment be left with the prothonotary or proper officer, who is to register the same in a book kept for the purpose.

Judgments or rules or orders of inferior courts of record, in which a barrister of not less than seven years' standing shall preside, may receive the same effect as those of a superior court by a judge's order to remove them into a superior court. But until execution be actually sued out, they will not affect lands in the hands of purchasers, mortgagors, or creditors, except so far as they would affect them as judgments of an inferior court.

In criminal proceedings, after trial the defendant can move in arrest of judgment at any time before judgment is pronounced, but this can only be done upon error appearing on the face of the record, and no motion of this sort can be made in the defendant's absence unless a verdict is found in which the jury reserve a point for the consideration of the court. After the judgment is recorded, a writ of error is necessary before it can either be reversed or altered. Formerly no judgment affecting the liberty of the individual could be pronounced in his absence, but this has been altered by the 11 Geo. IV. and 1 Wm. IV. c. 70, which enacts that upon trials for felonies or misdemeanours judgment may be pronounced whether the person affected be present or absent, except only in such cases of information as are filed by leave of the Court of Queen's Bench, or in cases of information filed by the attorney-general, where he prays that judgment may be postponed. The judgment of the court extends to the life and liberty of the offender according to punishment decreed to the offence against which the judgment is delivered. In some cases it extends to the compensation by forfeiture of the lands or goods, or both, of the offender; others induce a disability of holding offices, or fix a lasting stigma on the offender; and a large proportion are merely pecuniary by stated or discretionary fines.

On the subject of judgments see Chitty's 'General Practice;' Stephen, 'On the Principles of Pleading in Civil Actions;' Sugden's 'Vendors and Purchasers;' Prideaux, 'On the Law of Judgments as they affect Real Property.'

JUDICIAL COMMITTEE. [DELEGATES, COURT OF; PRIVY COUNCIL.]

JUDICIAL SEPARATION. [SEPARATION, JUDICIAL.]

JUDICIARY. [COURTS.]

JUDITH, an apocryphal book of the Old Testament, contains an account of the invasion of Syria and Judæa by Holofernes, general of Nabuchodonosor, king of the Assyrians, and particularly of the siege of Bethulia, a town in Judæa; and of the destruction of the Assyrian army, and of the death of Holofernes through the courage and stratagem of Judith, the widow of Manasses, and an inhabitant of Bethulia. The historical and geographical difficulties of this book are so great, and its narrative so improbable, that a great number of critics are disposed to consider it as a religious romance, probably written in the time of the Maccabees, to encourage the Jews in their struggles against the Syrian monarchs. Grotius considers it an allegory, written in the time of Antiochus Epiphanes; and that "by Judith is meant Judæa; by Bethulia, the temple or house of God; and by the sword which went out from thence, the prayers of the saints; that Nabuchodnosor denotes the Devil; and the kingdom of Assyria the Devil's pride," &c. Montfaucon ('La Verité de l'Histoire de Judith'), Huet ('Dem. ev. Prop.,' iv., p. 366), and Prideaux ('Connection,' vol. i., pp. 65-74), maintain, on the contrary, that it is a true history. Prideaux considers Nabuchodnosor to be the same person as Saosduchinus, the son of Esarhaddon, and grandson of Sennacherib; and Arphaxad, who is represented in Judith as the king of Media, to be only another name for Deioces. But in opposition to this, it should be remarked that there are many passages in the book which refer to a time subsequent to the Babylonian captivity. Josephus, also, who seldom neglects an opportunity of extolling the valour of his countrymen, takes no notice of this story.

The book of Judith was originally written in Chaldee, from which it was translated into Latin by Jerome. It was also translated into Greek and Syriac. The English translation in the authorised version was made from the Greek, and differs in many respects from the translation of Jerome, which is still extant in the Latin Vulgate.

There is a great similarity between the history of Judith and a tale which Quintus Curtius tells us respecting the death of Spitamenes (viii. 3).

(The *Introductions* of Eichhorn, Jahn, De Wette, Bertholdt, and Horne.)

JUGGERNAUTH, or more correctly Jagannatha, though probably a relic of Buddhism, is a comparatively modern idol, of whom the worship dates from a little before the Christian era. Jagannath, the lord of the world, is believed to be an incarnation of Vishnu, who under this name, with the assistance of his brothers Bala-Rama and Krishna, conquered Bahar. These incarnations, however, are very confused; Bala-Rama is sometimes identified with Krishna, and Krishna is a moiety of Vishnu. In Orissa Jagannath is known as Ram Chandra. Rama was a king of Oude, whose queen, Sita, having been carried off by the giant Ravana, was rescued by Bala-Rama, under the form of the monkey Hameman. From these come the three idols, Rama Chandra or Jagannath, Bala-Rama, and Sita. The idols themselves are ugly wooden busts of gigantic size, that of Bala-Rama is six feet high, Jagannath five feet, and Sita four feet. The image of the first is painted white, of the second black, and that of Sita yellow. The faces are large; the eyes of Jagannath are round, those of the other two are oval, from the ears of the males arms project horizontally forward, but the female lacks even this approach to the human form. A new image, according to Col. Phipps, in the 'Asiatic Journal' for March, 1824, is made about once in every seventeen years, from a Nim tree "on which no crow or other carrion bird has ever perched." Another tradition, related by Mr. Stirling, in 'Asiatic Researches,' vol. 15, says that Jagannath, or Vishnu, lived in Orissa under the form of Nil Madhava; his fame excited the attention of Indradyumna, Maharajah of Oujein, who desired to worship at the sacred shrine. On his arrival Madhava had disappeared, but in a dream he was told a fresh avatar would shortly take place, and accordingly a log of the Nim tree (*Melia azadirachta*) was seen to approach the coast, on which were seen conch shells, the lotus, &c., which was accepted as the new avatar, removed to a consecrated place, and on the first blow of the sacred axe it split into the three images already named, requiring nothing but the characteristic colouring.

The great temple of Juggernauth is said to have been built in A.D. 480, but it became completely buried in sand, and remained so until 1198, when it was restored. But Col. Sykes maintains, from no allusion ever being made to it, that it could not have existed in the 5th century; and no part of the present temple appears to be earlier in date than the 11th or 12th century. It stands in the sea-port town of Púró (Pooree), in the province of Orissa, and is a huge architectural mass, containing a sort of pyramidal tower, 210 feet high, built of coarse red granite, and covered with a rough coating of chunam, with two square pyramidal buildings adjoining, the top surmounted by an urn. They stand in the centre of a quadrangle enclosed by a high stone-wall, each side of which is 650 feet long, and 30 feet high. In front of the temple stands a column of elegant proportions, brought from an ancient temple to the sun at Kanarak. It is polygonal, of light and elegant appearance, and is surmounted by a figure of the monkey-deity Hameman. The material is a dark-coloured basalt. The entrances of the temple are flanked by colossal figures of lions or griffins, with mythological porters resting on their clubs carved on the side posts. It is a very conspicuous land-mark, and is of considerable importance to navigators on the flat and uniform coast where it is situated. The country, to the distance of about a mile from the sea, is a waste of deep loose sand; farther inland it consists of low sand-hills covered by a thick forest of dwarf-trees.

The festival of Jagannath, called Ruth Jatra, takes place every year, and the number of pilgrims is still very great, though much less than formerly, when Dr. Carey estimated them at 1,200,000; but in 1846 there were 180,000, and in 1849 and 1850 above 100,000. The idols are, in the first instance, dragged from their pedestals without decency or reverence, thrown down the steps, and hauled through the mud, until they reach the cars provided for each of them. That of Jagannath is 45 feet in height, that of Bala-Rama 44 feet, and that of Sita, or Subuhdra, 42 feet. The first has sixteen wheels, the second fourteen, the third twelve; and the platforms decrease in similar proportions. A small rail surrounds the platform of each car, in which an opening of a few feet is left in front of the idols. Cables are attached to the cars, and by these the pilgrims drag it about a mile and a half to its destination, and then back again, the whole procession occupying three days.

Mill, in his 'History of British India' (b. ii. c. 6), says, "It is customary for numbers of congregated persons to throw themselves under the wheels, and even fathers and mothers with their children in their arms. The chariot passes on, as if no impediment existed, and crushing them to death is supposed to convey them immediately to heaven." Professor H. H. Wilson says (in his edition of Mill's work), "this practice is modern: Jagannath himself is modern, and has no place in the Vaishnava Purunas. It is not improbable that the present shrine attained reputation as a place of pilgrimage no longer ago than a century" (that is, in 1740). Self-immolation has been prohibited by the government for many years, but numbers perish during the pilgrimage from disease or want of food. Lieut. Burton says, ('Pilgrimage to El Medinah and Mecca,') that "at Jaganath they worship a pyramidal black stone, fabled to have fallen from heaven, or miraculously to have placed itself on the place where the temple now stands;" and he seems to consider it as of the same nature as the Black Stone at the Kaaba of Mecca, which he thinks is an aërolite.

(Mill, *History of British India*, by Wilson; *Geographical, Statistical, and Historical Account of Orissa Proper," or Cuttack*, by A. Stirling, in *Asiatic Researches*, vol. xv.; W. F. B. Laurie, *The Idol Shrine*, 1851.)

JUGLANDIN. A non-azotised body of uncertain composition contained in green walnuts; the extract of walnuts is in fact impure juglandin. In contact with the air it becomes rapidly black, and on this account is sometimes employed as a hair-dye. It is also occasionally used in medicine.

JULIAN PERIOD is a term of years often employed in chronology, in order to avoid the ambiguity attendant on reckoning any time antecedent to our æra. The Julian Period consists of 7980 years, and is reckoned as having begun 4713 years before our æra; so that the present year 1860 corresponds to 6573 Jul. Per. The æra of the creation, or Anno Mundi, which has been used by Christian and Jewish writers, cannot be considered as a fixed point, as chronologists and controversialists are not agreed as to the precise time of its commencement, some placing the creation 4004 years B.C., others, such as the early Alexandrian Christians, 5502 B.C., and the Greeks and Russians at 5508 B.C. The Julian Period is produced by the multiplication of the lunar cycle 19, solar cycle 28, and Roman indiction 15. [PERIODS OF REVOLUTION.]

JULY, now the seventh, was originally the fifth, month of the year, and was called by the Romans, in regard to its numerical station, *Quintilis*. Mark Antony altered the name to Julius, the gentile name of Caius Cæsar, the Dictator, who was born in it. So Festus, "*Julium mensem appellarunt quod eo mense dicitur Julius natus.*"

In the old Latin or Alban calendar, Quintilis had a complement of 36 days. Romulus reduced them to 31; Numa to 30; but Julius Cæsar restored the day of which Numa had deprived it, which it has ever since retained.

Our Anglo-Saxon ancestors called July *Mæd-monath*, "mead month," from the meads being then in their bloom; and *litha-æftera*, "the latter mild month," in contradistinction to June, which they considered and named as "the former mild month."

JUNE, the sixth month of the year, named from the Latin *Junius*. Ovid, in his 'Fasti' (vi. 25) makes Juno assert that the name was expressly given in honour of herself:—

> "Ne tamen ignores vulgique errore traharis,
> Junius à nostro nomine nomen habet."

In another part of the 'Fasti' (vi. 87) he gives the derivation *à junioribus*; as May has been derived from *Majores*:—

> "Junius est juvenum; qui fuit ante senum."

Those who derive the name from Junius Brutus, who began his consulship in this month, forget that, according to tradition, it had received the appellation long before.

In the old Latin or Alban calendar June was the fourth month, and consisted of 26 days. Romulus is said to have assigned it a complement of 30 days. Numa, who made it the sixth month, deprived it of one day, which was restored by Julius Cæsar, since which time it has remained undisturbed.

The Anglo-Saxons had several names for the month of June. They called it *sear-monath*, "dry month"; *midsumer-monath*, "midsummer month"; and *litha-ærra*, "the earlier mild month," in contradistinction to July.

In this month is the summer solstice. Pitiscus tells us that in the Roman times the month of June was considered to be "nuptiis aptissimus."

JUNIPERUS COMMUNIS, *Medical Properties of.* The wood of the root and stem, the twigs or tops, with the leaves attached, and the fruits (*galbuli*, incorrectly termed berries), of the common juniper, all possess a peculiar aromatic flavour and odour, due to two peculiar oils, differing in their degree of volatility, which in chemical composition resemble French oil of turpentine, being destitute of oxygen, and therefore only carburets of hydrogen. In Britain the twigs and fruits, and oils thence obtained are officinal; on the continent the wood of the root and stem is used. From both, but especially the roots and thick branches, more oil can be extracted than from the wood of the trunk. This last is used to burn as incense and for pastiles. Articles of furniture made of it are not eaten by insects, as is the case also with cedar. The fruits are imported both from the north and south of Europe. Those from the latter are richest in volatile oil. The chemical analysis of Trommsdorff gives of volatile oil 1·0, wax 4·0, resin 10·0, a peculiar kind of sugar with acetate and malate of lime 33·8, gum with salts of potash and lime 7·0, lignin 35·0, water 12·9. The fruits require two years to ripen, but at the end of the first year, while yet green, they are richest in volatile oil; and they should be collected at that time. Much of the volatile oil is converted into resin during the second year. [GENEVA.] The fruits are seldom given, but may be rubbed up with sugar. The oil is, however, one of the most powerful of diuretics, four drops acting strongly on the kidneys. But the compound spirit of juniper is the form mostly employed for its exhibition. The preparation, according to the 'London Pharmacopœia,' is made by digesting the ingredients, consisting of the oil of juniper, with oils of caraway and fennel; but, according to the Edinburgh and Dublin Pharmacopœias, by distilling the fruits: the last is a more potent preparation.

JUNIPERUS SABINA, *Savine, Properties of.* Of this plant, the tops, fresh or dried, are used. They contain a volatile oil and resin. The odour is more like cajeput oil than like turpentine. The fresh plant is more active than the dried. Bruised or reduced to powder these leaves excite a rubefacient action to whatever part they are applied, and acute inflammation with ulceration is the result of their prolonged application. But action on the nerves, especially of the uterus, takes place, as well as increased activity of the veins, particularly of the liver. The external use of sabine, or savine, is proper under skilful direction, more particularly when diffused through fats or cerates, mostly to keep up a *perpetual* blister. But the internal use of savine is one of the most dangerous forms of popular quackery—often causing death. Its employment cannot be too much reprobated.

JUNO. [HERA.]

JUNO, one of the group of small planets which revolve between Mars and Jupiter. [ASTEROIDS.]

JUPITER. [ZEUS.]

JUPITER, the name of one of the old planets, the largest of all the bodies, except the sun, in the solar system. The astronomical history of this planet (or of any other, except the newly-discovered small planets) is so completely entangled in that of the progress of astronomy in general and pure mathematics, that it would be useless to attempt any separation. In the article GRAVITATION will be found the most remarkable points of what an astronomer would call the *theory* of Jupiter, meaning the explanation of his motions by means of the law of gravitation. We shall here confine ourselves to the statement of the elements of the planet's motion, and that of the satellites.

The figure of Jupiter is sufficiently oblate to appear of a sensibly spheroidal form in a moderate telescope. According to the recent researches of Mr. Main, the axis of revolution is to the equatorial diameter in the proportion of 15·84 to 16·84. The apparent equatorial diameter varies between half and three-quarters of a minute, being 37″·91, when the planet is at its mean distance from the earth. The real equatorial diameter is 11·46 times that of the earth, or upwards of 91,000 miles. Its mean density is nearly the same as that of the sun or about one-quarter of that of the earth.

The mass of Jupiter, from the time of Newton to the present, was supposed to be to that of the sun in the proportion of 2 to 2141; but the recent observations of various astronomers, concluding with those of Mr. Airy, contained in the 'Memoirs of the Astronomical Society,' make it somewhat greater. Mr. Airy's result is that the mass of Jupiter is to that of the sun in the proportion of 1 to 1046·77, or 2 to 2094 nearly.

Elements of the Orbit of Jupiter.

Epoch 1799, December 31, 12^{h} mean astronomical time at Paris.

Semiaxis major 5·20115524, that of the earth being assumed as the unit.

Excentricity ·0481621; its secular increase (or increase in 100 years) ·0001594.

Inclination of the orbit to the ecliptic 1° 18′ 52″; its secular diminution 23″.

Longitudes from the mean equinox of the epoch (1) of the ascending node 98° 25′ 44″·90; its secular increase (combined with the precession) 3430″; (2) of the perihelion 11° 7′ 38″·26; its secular increase (combined with the precession) 5710″; (3) of the planet (mean) 81° 52′ 19″·33.

Mean sidereal motion in 365¼ days 109256″·59; sidereal revolution 4332·5848212 mean solar days.

When observed with a telescope of sufficient power, the surface of this planet is perceived to be diversified by faint belts extending in parallel directions across his disc. These belts are observed to vary in magnitude and number; but in general three belts are conspicuous, forming a zone across the body of the planet, and extending in a direction nearly parallel to the plane of his orbit. Jupiter, like several of the other planets, is observed to revolve on a fixed axis. The earliest surmise of this fact is due to Kepler, who inferred, from the rapid motion of the satellites of the planet compared with the slower motion of the moon around the earth, that Jupiter rotates more rapidly than the earth does. The subsequent observations of astronomers with the telescope have confirmed this interesting conjecture. Hooke appears to have first discovered the rotation of the planet. In the month of May, 1664, while engaged in a telescope survey of the planet he discovered a small spot on the largest of the three belts, which, in the course of two hours, travelled from east to west over a space equal to about half the diameter of the planet. It was reserved for Cassini to assign the period of rotation with some degree of precision. Having found that the planet generally presented a very altered appearance after the lapse of five hours, he concluded that the time of rotation must be somewhere about ten hours. From observations of a spot near the southern belt of the planet, he found that in 12^{d} 0^{h} 4^{m}, it returned to the same position on the disc. During this interval the planet must have effected twenty-nine complete rotations. It hence resulted that the time of rotation amounted to 9^{h} 56^{m}. The subsequent observations of Cassini indicated that the spots, besides participating in the rotation of the planet, have a proper motion on his surface. The elder Herschel established the existence of this fact beyond all doubt. He found that the time of rotation as indicated by the return of the spots to the same position on the disc fluctuated between 9^{h} 55^{m} 40^{s} and 9^{h} 50^{m} 48^{s}.

The most reliable determination of the time of rotation is due to Mr. Airy, whose observations of the planet were made at Cambridge in the years 1834–5. Having watched the motion of a spot on the apparent lower belt from December 16, 1834, to March 19, 1835, during which period the planet had effected 225 complete rotations, he hence concluded that the time of rotation is 9^{h} 55^{m} 21·3^{s}. The inclination of Jupiter's equator to the ecliptic amounts to 3° 5′ 30″,

The telescopic appearance of Jupiter seems to indicate that the body of the planet is enveloped in a cloudy atmosphere of great density. This opinion is strengthened by the variable appearance of the spots on his surface. Sir William Herschel supposed that the spots represent dense masses of clouds. He ascribes their variable motion to the prevalence of winds in the atmosphere of the planet, which blow periodically in the same direction. He also endeavours to explain the gradual increase observable in the motion of a spot after its first appearance, by the circumstance, that some period of time must necessarily elapse before the spot can acquire the full velocity of the wind by which it is impelled. From his observations of the spots, he inferred that in some instances the winds travel at the rate of somewhat more than 200 miles in an hour. This, however, does not exceed the velocity of occasional winds on the earth's surface. Mr. De La Rue has executed an admirable delineation of the physical features of the planet.

The discovery of the important fact that Jupiter is accompanied by four satellites is due to Galileo. Having examined the planet with a new telescope on the 7th of January, 1610, his attention was drawn to three small but very bright stars which appeared in the vicinity of the planet, two on the east side of his disc, and one on the west side. On the following evening he again perceived the stars, but their arrangement with respect to the planet was not the same as it was previously. On the 13th he perceived four stars in the vicinity of the planet. By continuing his observations he established beyond all doubt the fact that the four stars seen by him revolved regularly around the planet, and he even arrived at a rough approximation of their times of revolution.

The four satellites of Jupiter appear to revolve on axes, each in the time of its revolution round the planet, in the same manner as our moon. The elements of their orbits are as follows (Baily, 'Astron. Tables and Formulæ'): the units of time, length, and mass being the earth's mean solar day, the planet's equatorial semidiameter, and the planet's mass.

Sat.	Sidereal Revolution.				Mean Distance.	Mass.
				More nearly.		
	d.	h.	m.	d.		
1	1	18	28	1·769137788148	6·04853	·0000173281
2	3	13	14	3·551810117849	9·62347	·0000232355
3	7	3	43	7·154552783970	15·35024	·0000884972
4	16	16	32	16·688769707084	26·99835	·0000426591

The first satellite has no sensible excentricity, and its orbit is very nearly indeed in the plane of Jupiter's equator. The second has no sensible excentricity; the inclination of its orbit to the planet's equator is under half a minute, and its nodes have a retrograde revolution of about thirty years. The third has a small but very variable excentricity, and the line of apsides has a direct but variable motion. The inclination of its orbit is under a quarter of a minute, and the nodes make a retrograde revolution in about 142 years. The fourth has a greater excentricity, and the direct mean motion of its apsides is nearly three-quarters of a degree per annum. The nodes made by its orbit with that of the planet have a direct motion of 4½ minutes per annum, and the inclination of the orbit to that of Jupiter is 3° nearly.

The apparent diameters of the satellites were determined by W. Struve with a micrometric apparatus attached to the great refractor of the Dorpat Observatory. The following are the apparent diameters which they would subtend if viewed at the mean distance of the planet from the earth:—

Apparent diameter of 1st satellite . . .	1″·015
„ „ 2nd „	0″·911
„ „ 3rd „ . . .	1″·488
„ „ 4th „	1″·273

These measures indicate the absolute diameters of the satellites, counting outwards from the planet, to be respectively, 2429 miles, 2180 miles, 3561 miles, and 3046 miles.

In consequence of the smallness of the angle by which Jupiter's equator is inclined to the ecliptic, and of the nearness of the orbits of the satellites to the plane of the equator, all the satellites, except the fourth, which sometimes escapes, undergo one eclipse once in every revolution. Since [ECLIPSE] this is caused by the entry of the satellite into Jupiter's shadow, the eclipse is independent of the earth's position, and the observation can certainly be made, unless Jupiter be too near to the sun. It is found that an immersion or emersion is not visible, generally speaking, unless Jupiter be as much as 8° above the horizon, and the sun as much as 8° below it. It never happens that both the immersion and emersion can be observed, in the case of the first satellite, and rarely in that of the second; though it is otherwise with the third and fourth. The reason is, that the planet itself always hides a part of its own shadow, and the first satellite is so near the planet that it must either enter or leave the shadow behind the planet; which also happens, for the most part, in the case of the second satellite. Before the planet is in opposition its shadow is on the western side of the planet, and after opposition on the eastern; while before the opposition immersions only are visible, and after opposition emersions, in the case of the first and second satellites. The eclipses of the four several satellites last about 2¼, 2¾, 3½, and 4¼ hours, one time with another. For the use of these eclipses in determining Longitude, see that word.

JURISDICTION. This term is the Latin word *Jurisdictio*, which simply signifying the "declaration of jus or law," was used by the classical writers to express the "administration of Justice" (Cic. 'Fam.' 2 ep. 13 ad fin.) as well as "legal authority." (Cic. 'Agrar.' 2, c. 36; Sueton, Calig. c. 16). He who had *jurisdictio* was said "jus dicere," to "declare the law." The whole office (*officium*) of him who declared the law was accordingly expressed by the word *Jurisdictio*. (D. 2, 1.). *Jurisdictio* was either voluntary (*voluntaria*) or litigant (*contentiosa*). The *jurisdictio voluntaria* related to certain acts, such for instance as those forms of manumission and adoption which must be done before a *magistratus* in order to be valid; it is therefore described in the law books as an *actio legis* (D. 1, 16, 3, & D. 1, 20, 1). The *jurisdictio contentiosa* related to litigation, and such legal proceedings were said to be "in jure," before the magistratus, as opposed to the proceedings before a *judex*, which were said to be "in judicio." The magistratus was said "jus dicere" or "reddere," when he exercised his functions; and "magistratus" and "qui Romæ jus dicit" are accordingly convertible terms (Warnkœnig, 'Institutiones Juris Romani,' lib. iv. cap. i. tit. vii., and Abdy's 'Law of Civil Procedure among the Romans,' chap. ii.) Jurisdiction in England, which is defined by Coke to be "Potestas de Publico introducta cum necessitate Juris dicendi," 10 Co. 73, and is explained to be an "authority or power which a man has to do justice in causes of complaint brought before him," means an authority which a court of law or equity has to decide matters that are litigated before it or questions that are tried before it. The courts at Westminster have jurisdiction all over England and Wales; but the jurisdiction of other courts is limited by being confined to certain limits of space and to certain kinds of causes or matters in dispute. When the jurisdiction of a court extends all over England, it may still be limited as to the kind of causes which it tries. Thus, the superior courts of law and the courts of equity have their several jurisdictions as to matters which they hear and determine. [Equity.] The ecclesiastical courts also have their separate jurisdiction; and other courts, such as the Probate and Divorce Court, Admiralty Court, the Court of Insolvency, Borough Courts, County Courts, and others, have their several jurisdictions. It follows, that if proceedings are commenced against a man before a court which has no jurisdiction in the matter brought before it, the defendant may answer by alleging that the court has no jurisdiction; which is called pleading to the jurisdiction. When a party is convicted by a court that has no jurisdiction in the matter, the proceedings may be moved into the Court of Queen's Bench by the writ of Certiorari and quashed. [Certiorari.] Those who have limited jurisdiction are liable to an action, if they assume a jurisdiction which they have not. See Paley on 'Convictions,' 4th edition, p. 400, and 11 & 12 Vict. c. 44, s. 2.

JURISPRUDENCE. The Latin word *prudentia* (contracted from *providentia*) came, by a natural transition, to mean *knowledge* or *understanding*. "Habebat" (says Nepos, 'Life of Cimon,' c. 2) "magnam prudentiam tum juris civilis tum rei militaris;" hence persons skilled in the Roman law were called *juris prudentes*, or simply *prudentes*; in the same manner they were called *consulti*, as well as *juris consulti*. (Haubold's 'Lineamenta Instit. Juris Romani,' lib. iv., cap. 5; Hugo, 'Geschichte des Römischen Rechts,' p. 458, ed. xi.) A large part of the Roman law was gradually adopted by the legislature and the judices from the writings of the jurists: the emperors moreover sometimes appointed persons whose opinions (or *responsa*) the judex was bound to follow. (D. 1. 2. 2, §§ 5, 7, and 35. 47; 'Inst.' 1. 2. 8.) According to the acceptation of the term *prudens* or *juris prudens* in the Roman law, *juris prudentia* is sometimes limited to the dexterity of a practical lawyer in applying rules of law to individual cases; whence the technical use of the term *jurisprudence* in the French legal language for law founded on judicial decisions, or on the writings of jurists.

By *general jurisprudence* is properly meant the science or philosophy of positive law, as distinguished from *particular jurisprudence*, or the knowledge of the law of a determinate nation. "General jurisprudence, or the philosophy of positive law, is not concerned directly with the science of legislation: it is concerned directly with principles and distinctions which are common to various systems of particular and positive law, and which each of those various systems inevitably involves, let it be worthy of praise or blame, or let it accord or not with an assumed measure or test. General jurisprudence is concerned with law as it necessarily is, rather than with law as it ought to be; with law as it must be, be it good or bad, rather than with law as it must be, if it be good." (Austin's 'Outline of a Course of Lectures on General Jurisprudence,' p. 3.) For example, every system of positive law must involve such notions as sovereignty, legal right, legal duty, legal sanction, civil or criminal injury, the grounds of imputation or legal guilt, and of non-imputation or legal innocence, property, possession, &c., which therefore belong to the province of general jurisprudence. [Law; Legislation.]

A systematic treatise on general jurisprudence does not fall within the scope of this Cyclopædia. A detailed, precise, and lucid description of the province of general jurisprudence will be found in Mr. Austin's work on the subject (8vo., London, 1832), and the annexed outline of a course of lectures. Bentham's 'Traités de Législation' also contain much valuable matter relating to this subject. A list of works on general jurisprudence may be seen in Krug's 'Philosophisches Lexicon,' in the article *Rechtslehre*.

JURY (in English law) is a term denoting an assembly of men authorised to inquire into or determine facts, and bound in both cases by an oath to the faithful discharge of their duty. The etymological derivation of the term is obviously from *juro*, to swear, whence we find this institution called in forensic Latin *jurata*, and the persons composing it *jurati*; in French, *les jurés*; and in English, *the jury*. When the object is inquiry only, this tribunal is sometimes called an inquest or inquisition, as in the instance of a grand jury or coroner's inquest; but when facts are to be determined by it for judicial purposes it is always styled a jury. When the trial by jury is spoken of in popular language at the present day, it signifies the determination of facts in the administration of civil or criminal justice by twelve men sworn to decide facts truly according to the evidence produced before them.

Inquiry into facts on behalf of the crown by means of juries was frequent in England long before the trial by jury was commonly used in courts of justice for judicial purposes. Thus we find, immediately after the Conquest, inquisitions *ad quod damnum* (which anciently took place in all grants by the crown, though now of more limited use); inquisitions *post mortem*, which were instituted on the death of the king's tenants, to ascertain of what lands they died seised; inquisitions of lunacy (*de lunatico inquirendo*); and several other inquests, which were called inquests of office, and took place where the crown was concerned in interest: all of these inquiries were made by means of juries of the neighbourhood, who were presumed to be necessarily conversant with the facts. So in England also in the reign of John, when the lands of the Normans were seised into the hands of the king, inquisitions by jury were executed in each county to ascertain their value and incidents. (Hardy's 'Rotuli Normanniæ,' vol. i., p. 122.)

Besides these juries of inquiry (*inquisitoria jurata*), there were accusatory juries (*jurata delatoria*), who presented offences committed within their district or ward, hundred, or county, to the king or his commissioned justices. These inquests were immediately connected with the administration of justice, their duty being to charge offenders, who, upon such accusation, were put upon their trial before judges, and were afterwards condemned or "delivered" by them according to the result of the trial. Though the character, incidents, and duties of these accusatory juries in early times are involved in much obscurity, there is little doubt that they formed the origin of our present grand juries.

The number of persons composing juries of inquiry and accusatory juries was arbitrary, and might consist of more or occasionally of fewer than twelve men.

The third species of jury is the institution by which disputed facts are to be decided for judicial purposes in the administration of civil or criminal justice, and which is in modern times familiar to us under the denomination of *trial by jury*. Juries of this description have been considered to exercise the same functions as the *dicastæ* (δικασταί) of the Athenians and the *judices* of the Romans, and our trial by jury has accordingly sometimes been considered to have been derived immediately from Rome, and ultimately from Greece. The precise time at which this species of trial originated in England has been the subject of much animated discussion; and in particular the question whether it was known to the Anglo-Saxons, or was introduced by the Conqueror, has been warmly debated. Coke and Spelman, among earlier legal antiquaries, and, in later times, Nicholson (Preface to Wilkins's 'Anglo-Saxon Laws'), Blackstone, and Turner ('Anglo-Saxons,' vol. iv., b. xi., c. 9), maintain with much confidence the existence of this institution before the Conquest. On the other hand, Hickes ('Dissert. Epist.,' p. 34), Reeves ('History of the English Law,' vol. i., p. 24), and several other learned writers, contend that it was introduced by the Conqueror, or at least that it was derived from the Normans, and was not of Anglo-Saxon origin. The latter opinion is adopted by Sir Francis Palgrave, 'History of the English Commonwealth,' v. i., p. 243.

Without entering minutely into this controversy, it may be stated that the traces of the trial by jury, in the form in which it existed for several centuries after the Conquest, are more distinctly discernible in the ancient customs of Normandy than in the few and scanty fragments of Anglo-Saxon laws which have descended to our time. The trial by 12 compurgators, which was of canonical origin and was known to the Anglo-Saxons and also to many foreign nations, resembled the trial by jury only in the number of persons sworn; and no conclusion can be drawn from this circumstance, as 12 was not only the common number throughout Europe for canonical and other purgations, but was the favourite number in every branch of the polity and jurisprudence of the Gothic nations. (Spelman, 'Gloss.,' tit. 'Jurata.') Besides this, the trial by compurgators under the name of Wager of Law continued to be the law of England till abolished, in 1833, and is treated by all writers and noticed in judicial records ever since the Conquest as a totally different institution from the trial by jury. The trial *per sectatores* or *per pares* in the county court, which has sometimes been confounded with the trial by jury, was in truth a totally different tribunal. The sectatores or pares were, together with the sheriff or other president, judges of the court; and it appears to have been the common course with the Gothic nations that twelve assessors should be present with the king or judge to decide judicial controversies. (Du Cange, ‘Gloss.,’ ad vocem ‘Pafes.’) The *pares curiæ* resembled permanent assessors of the court, like the *scabini* mentioned in the early laws of France and Italy, much more nearly than sworn jurors indiscriminately selected, and performing a subordinate part to the judge. On the other hand, the incidents of the mode of trial prevalent in Normandy long before the Conquest correspond in a striking manner with those of our trial by jury as it existed for centuries afterwards. Thus in Normandy offenders were convicted or absolved by an inquest of good and lawful men summoned from the neighbourhood where the offence was surmised to have been committed. The law required that those were to be selected to serve on such inquest who were best informed of the truth of the matter; and friends, enemies, and near relatives of the accused were to be excluded. So also in the Norman Writ of Right, those were to be sworn as recognitors who were born and had ever dwelt in the neighbourhood where the land in question lay, in order that it might be believed that they knew of the truth of the matter, and would speak the truth respecting it. (‘Grand Coustumier,’ cap. 68, 69, 103.) These incidents, though unlike our present mode of trial (which, as will presently be shown, has entirely altered its character within the last four centuries), are nearly identical with the trial by jury as it is described first by Glanville and afterwards by Bracton, and correspond almost verbally with the form of the jury process, which has continued the same from very early times to the present day, by which the sheriff is commanded to return “good and lawful men of the neighbourhood, by whom the truth of the matter may be better known, and who are not akin to either party, to recognise upon their oaths,” &c. On the other hand (as Madox remarks, in his ‘History of the Exchequer,’ p. 122), “if we compare the laws of the Anglo-Saxon kings with the forms of law process collected by Glanville, they are as different from one another as the laws of two several nations.”

Though there are some traces of the trial by jury in the four reigns which immediately succeeded the Norman Conquest, it was not till a century afterwards, in the reign of Henry II., that this institution became fully established and was reduced to a regular system. Its introduction into frequent use at this period was probably owing to the law or ordinance for the trial by assize in pleas of land or real actions, made by Henry II. This law has not come down to our times, but it is fully described by Glanville (lib. ii. cap. 7), and the greater part of the treatise of that writer is occupied by an account of the practical machinery of the trial by twelve men, which he warmly eulogises and represents as having been introduced in opposition to the unsatisfactory mode of trial by battle or duel. In the reign of Henry II. it appears also that a jury was sometimes used in matters of a criminal nature—the proceeding in such cases being noticed as an inquiry *per juratam patriæ vel vicineti*, or *per juramentum legalium hominum*. Thus in the ‘Constitutions of Clarendon,’ enacted in 1164, it is directed that “if no person appeared to accuse an offender before the archdeacon, the sheriff should, if requested to do so by the bishop, cause twelve lawful men of the neighbourhood or of the township to be sworn, who might declare the truth according to their conscience.” These however were probably accusatory juries, similar to our grand inquests, and not juries employed for the actual trial or “deliverance” of criminals, which do not seem to have been commonly used until a later period.

The law of Henry II. introduced the trial by assize or jury in real actions as a mode of deciding facts which the subject might claim as a matter of right. Glanville calls it “a certain royal benefit conferred upon the people by the clemency of the sovereign with the advice of the nobility.” Accordingly we find in the ‘Rotuli Curiæ Regis’ in the time of Richard I. and John, many instances of trials by jury being claimed by parties, though it appears from these curious records that at this period the trial by battle was still in frequent use. In the reign of John we first begin to trace the use of juries for the trial of criminal accusations. At first it seems to have been procured by the accused as a special favour from the crown, a fine, or some gift or consideration, being paid in order to purchase the privilege of a trial by a jury. Several instances of this kind will be found collected in the notes and illustrations to Palgrave's ‘Commonwealth of England,’ vol. ii., p. 186. The payment of a fine took place also not unfrequently in civil cases, where any variation from the regular course was required; see ‘Rotuli Curiæ Regis,’ vol. i., pp. 354, 375; vol. ii., pp. 72, 92, 97, 101, 114. It is quite clear, however, from Bracton and Fleta, that at the end of the 13th century the trial by jury in criminal cases had become usual, the form of the proceedings being given by them in detail. (Bracton, p. 143.) Introduced originally as a matter of favour and indulgence, it gained ground with advancing civilisation, gradually superseding the more ancient and barbarous customs of battle, ordeal, and wager of law, until at length it became, both in civil and criminal cases, the ordinary mode of determining facts for judicial purposes.

It is right to notice the popular and remarkable error that the stipulation for the *judicium parium* in Magna Charta referred to the trial by jury. Sir Edward Coke in his commentary upon Magna Charta expressly distinguishes between the trial by peers and the trial by jury (2nd Inst. 48-9); but Blackstone says, “The trial by jury is that trial by the peers of every Englishman, which, as the grand bulwark of his liberties, is secured to him by the Great Charter.” (‘Commentaries,’ vol. iv., p. 349.) This is confounding two distinct modes of trial. The *judicium parium* was the feudal mode of trial, where the *pares* or *convassalli ejusdem domini* sat as judges or assessors with the lord of the fee to decide controversies arising between individual *pares*. It was a phrase perfectly understood at the period of Magna Charta, and the mode of trial had been in use long before in France and all parts of Europe where feuds prevailed. (Du Cange, ‘Gloss.’, ad vocem ‘Pares.’) It was essentially different from the trial by jury, which could never be accurately called *judicium parium*. We read frequently in the records of those times (and even in Magna Charta itself), of *juratores*, of *veredictum* or *juramentum legalium hominum*, and *jurata vicineti* or *patriæ*, all of which expressions refer to a jury; but not a single instance can be found in any charter, or in any ancient treatise or judicial record, in which the jury are called *pares*, or their verdict *judicium*. (Reeves's ‘History of the Law,’ vol. i., p. 249.) In the records of the ‘Curia Regis’ in the first year of John's reign, among numerous entries of *Ponit se super juratam vicineti* or *patriæ*, are also entries of *Ponit se super pares suos de eodem feodo*, plainly indicating a distinction between the two modes of trial. (‘Rotuli Curiæ Regis,’ vol. ii., p. 90.)

Until about the reign of Henry VI. the trial by jury was to all intents and purposes a trial by witnesses. The present form of the jurors' oath is that they shall “give a true verdict, *according to the evidence*.” At what precise time this form was introduced is uncertain; but for several centuries after the Conquest, the jurors both in civil and criminal cases were sworn merely *to speak the truth*. (Glanville, lib. ii., cap. 17; Bracton, lib. iii., cap. 22; lib. iv., p. 287, 291; Britton, p. 135.) Hence their decision was accurately termed *veredictum*, or verdict; whereas the phrase “true verdict” in the modern oath is not only a pleonasm, but is etymologically incorrect, and misdescribes the office of a juror at the present day. Many other incidents of the trial by jury, as recorded in ancient treatises, conclusively show that the jury were merely witnesses. They were brought from the neighbourhood where the disputed fact was suggested to have occurred, because, as the form of the jury process says, they were the persons “by whom the truth of the matter might be better known;” no doubt upon the principle that *Vicini vicinorum præsumuntur scire*. Again, if the jurors returned by the sheriff in the first instance declared in open court that they knew nothing of the matter in question, others were summoned who were better acquainted with it. (Glanville, lib. ii., cap. 17.) They might be excepted against by the parties upon the same grounds as witnesses in the Court Christian. They were punished for perjury if they gave a wilful false verdict; and for *crassa ignorantia* if they declared a falsehood or hesitated about their verdict upon a matter of notoriety, which all of the country (*de patriâ*) might and ought to have known. (Bracton, p. 290.) And ancient authors solemnly admonish judges to “take good heed in inquisitions touching life and limb, that they diligently examine the jurors from what source they obtain their knowledge, lest peradventure by their negligence in this respect Barabbas should be released and Jesus be crucified.” (Bracton, lib. iii. cap. 21; Fleta, lib. i., cap. 34.) It is also remarkable, as one of the numerous circumstances which show the character of the jury in the earlier periods of the history of the institution, that though all other kinds of murder might be tried by a jury, murder by poison was excepted, “because,” say the ancient writers, “the crime is so secret that it cannot be the subject of knowledge by the country.” (Bracton, lib. iii., cap. 18; Fleta, lib. i., cap. 31.)

The original principle and character of the trial by jury in criminal cases in Scotland appear to have been the same as in England. The following extract is taken from a curious paper delivered to the Speaker of the House of Commons, and recorded on the Journals at the date 4th June, 1607. (‘Comm. Journ.’, vol. i., p. 378.) “In Scotland criminal cases are not governed by the civil law; but *ordanes* (a word printed by mistake for some other) and juries pass upon life and death, very near according to the law here (in England). Which jury being chosen out of the Four Halfs about (as the Scottish law terms it), which is to say, out of all places round about that are nearest to that part where the fact was committed, the law doth presume that the jury may the better discern the truth of the fact by their own knowledge; and therefore they are not bound to examine any witnesses, except out of their own disposition they shall please to examine them in favour of the party pursuer; which is likewise very seldom or almost never used. It is of truth that the judge may either privately beforehand examine such witnesses as either the party pursuer will offer unto him, or such others as in his own judgment he thinks may best inform him of the truth; and then when the jury is publicly called and admitted, he will cause these depositions to be produced and read; and likewise if the party pursuer desire any witness there present to be examined, he will publicly do it in presence of the jury and both parties.” It will be observed, that the mode of commencing the introduction of evidence to juries as described in this document bears a strong resemblance to the growth of the proceeding in England.

The earliest traces of the examination of witnesses or of evidence being laid before juries in England, which formed the commencement of a total change in their character, occur in the reign of Henry VI. The change was not effected suddenly, or by any particular act of parliament, but was introduced by slow degrees as population increased, and the habits and manners of society underwent alteration; and though distinctly discernible in the reign of Henry VI., was not completely effected before the times of Edward VI. and Mary. Fortescue, in the 26th chapter of his work 'De Laudibus Legum Angliæ,' written at the end of the reign of Henry VI., and about the year 1470, expressly mentions that witnesses were examined and sworn before the jury; but he calls the jury indiscriminately *testes* and *juratores*, and makes frequent allusions to their character as witnesses. Shortly after Fortescue's time—namely, in the year 1498—there is a reported case between the Bishop of Norwich and the Earl of Kent ('Year Book,' 14 Henry VII.), in which a jury had been separated by a tempest "while the parties were showing their evidence;" and one question raised for the opinion of the court was, whether, when the jury came together again, they were competent to proceed with the case and to give a verdict. The objection pressed was that the jury had separated before the evidence was given; to which it was answered that "the giving the evidence was wholly immaterial, and made the matter neither better nor worse; that evidence was only given in order to inform the consciences of the jury respecting the rights of the parties; but that if neither party chose to give evidence, still the jury would be bound to deliver a verdict."

About the same period,—that is, in the reign of Henry VII.,—it appears from records printed in Rastell's Entries, that demurrers to evidence were an acknowledged form of proceeding, which shows that at that time evidence of some kind was given, and consequently that the character of the jury had been in some degree changed from that of *witnesses* to that of *judges* of facts upon testimony. The proofs mentioned in these records are called *evidentia;* and it is most probable that at first the only evidence given consisted of deeds, writings, and of depositions of absent witnesses taken before the justices of the peace or other magistrates, and that oral testimony was not common until a later period. The entire absence of all mention of evidence or witnesses, as contradistinguished from jurors, in treatises, reports, records, or statutes, previously to the 16th century, strongly corroborates the fact of the early character of the trial by jury. There is no trace of any rules of evidence, nor of any positive law compelling the attendance of witnesses, or punishing them for false testimony or non-attendance, nor of the existence of any process against them before the stat. 5 Eliz. c. 9 (1562). In the case of Summers *v.* Mosely, reported in 2 Crompton and Meeson, p. 485, Mr. Baron Bayley says that he had been unable to find any precedents of the common *Subpœna ad testificandum* of an earlier date than the reign of Elizabeth, and expresses a conjecture that this process may have originated with the above-mentioned statute. The *Subpœna ad testificandum* does not appear in the registers of Writs and Processes until the reign of James I. (West's 'Symboleography.') Witnesses were examined orally upon the trial of Sir Thomas More, in the reign of Henry VIII.; but the reported state trials in the reigns of Edward VI. and Mary show that the practice in that respect was then by no means settled. In the reign of Elizabeth, however, there is abundant proof, from Sir Thomas Smith's 'Commonwealth of England,' and other authorities, that oral testimony was used without reserve (except in state prosecutions) both in civil and criminal trials; and consequently it cannot be doubted that about the middle of the 16th century the trial by jury had fully assumed the character in which we are now familiar with it—namely, an institution deciding facts for judicial purposes by means of testimony or evidence produced before the jury.

This view of the original character and office of the jury seems to account for the practice of fining or otherwise punishing juries by the court when they gave an unsatisfactory verdict; a practice which was partially continued, though not without remonstrance by legal authorities, after the nature of the institution had been changed. If juries, who were merely witnesses sent for to inform the court of facts which they were presumed certainly to know, returned a wilfully false verdict, they were guilty of a contempt of justice, and might properly be punished; but when their character was changed, and their verdict depended not on their own knowledge of the facts, but upon the impressions produced on their minds by the evidence, such a course of summary punishment became intolerable injustice; and though occasionally practised in the 16th century, was declared to be illegal soon after the Restoration by the celebrated judgment in Bushell's case, reported in Vaughan's Reports, p. 135.

The juries now in use in England in the ordinary courts of justice are grand juries, petty or common juries, and special juries. Grand juries are exclusively incident to courts of criminal jurisdiction; their office is to examine into charges of crimes brought to them at assizes or sessions, and if satisfied that they are true, or at least that they deserve more particular examination, to return a bill of indictment against the accused, upon which he is afterwards tried by the petty jury. A grand jury must consist of twelve at the least. In practice a greater number usually serve, but twelve must concur in finding every indictment. No further qualification is required for grand jurors (except in the case of grand jurors at the sessions of the peace, provided for by the recent Jury Act) than that they should be freeholders, though to what amount is uncertain; or freemen, lawful liege subjects, and not aliens or outlaws. (Hawkins's 'Pleas of the Crown,' chap. 25, sect. 16.)

Until the end of the 13th century the only qualification required for petty or common juries, for the trial of issues in criminal or civil courts, was that they should be "free and lawful men;" *freemen*, as holding by free services or free burgesses in towns; and *lawful* men, that is, persons not outlawed, aliens, or minors, but entitled to the full privileges of the law of England. By the statute of Westminster 2, passed in the 13th year of Edward I. (1296), it was enacted that no man should be put on juries who had not some freehold of the value of 20*s.* a year within the county, or 40*s.* without it; and this qualification was raised to 40*s.* in counties by the statute 21 Edward I. The object of these statutes was to protect poor persons from being oppressed and injured by being summoned on juries, and also to obviate the evil of the non-attendance of jurors, which frequently occurred from their inability to leave their agricultural or handicraft occupations. The stat. 2 Henry V. however was expressly intended to secure the intelligence and responsibility of jurors by requiring a property qualification. With this view it enacted that no person should be a juror in capital trials, nor in any real actions, or personal actions where the debt or damages declared for amounted to 40 marks, unless he had lands of the yearly value of 40*s.*: and if he had not this qualification he might be challenged by either party. This continued to be the qualification of common jurors until the passing of the statute 6 George IV., c. 50, which repealed all former statutes upon this subject, and entirely remodelled the law respecting juries. By this statute "every man (with certain specified exceptions) between the ages of twenty-one years and sixty years who has within the county in which he resides 10*l.* a year in freehold lands or rents, or 20*l.* a year in leaseholds for unexpired terms of at least twenty-one years, or who, being a householder, is rated to the poor-rate in Middlesex on a value of not less than of 30*l.*, and in any other county of not less than 20*l.*, or who occupies a house containing not less than fifteen windows, is qualified and liable to serve on juries in the superior courts at Westminster and the courts of the counties palatine for the trial of issues to be tried in the county where he resides, and also to serve on grand juries at the sessions of the peace, and on petty juries, for the trial of issues triable at such sessions in the county in which he resides." The exceptions are:—peers, judges of the superior courts, clergymen, Roman Catholic priests, dissenting ministers following no secular employment but that of a schoolmaster, serjeants and barristers at law, and doctors and advocates of the civil law actually practising; attorneys, solicitors, and proctors actually practising; officers of courts actually exercising the duties of their respective offices; coroners, gaolers, and keepers of houses of correction; members and licentiates of the college of physicians actually practising; surgeons, being members of one of the royal colleges of surgeons in London, Edinburgh, or Dublin, and actually practising; apothecaries certificated by the Apothecaries' Company and actually practising; officers in her majesty's navy or army on full pay; pilots licensed by the Trinity House; masters of vessels in the buoy and light service; pilots licensed by the lord-warden of the cinque-ports, or under any act of parliament or charter; household servants of the sovereign; officers of customs and excise; sheriffs' officers, high constables, and parish clerks.

Lists of all persons qualified to be jurors are made out by the churchwardens and overseers of each parish, and fixed on the church door for the first three Sundays in September in each year; these are afterwards allowed at a petty sessions and then delivered to the high constable, who returns them to the next quarter-sessions for the county. The clerk of the peace then arranges the lists in a book, which is called the 'Jurors' Book' for the ensuing year, and afterwards delivers it to the sheriff. From this book the names of the jurors are returned in panels to the different courts.

Special juries are composed of such persons as are described in the 'Jurors' Book' as esquires, and persons of higher degree, or as bankers or merchants; and it is the duty of the sheriff to make a distinct list of such persons, which is called the 'Special Jurors' List.' When a special jury is ordered by any of the courts, which must always be the result of a special application of one of the parties, 48 names are taken by ballot from this list in the manner particularly described in the statute, which are afterwards reduced to 24 by means of each party striking out 12; and the first 12 of these 24 who answer to their names in court are the special jury for the trial of the cause.

The legitimate mode of objecting to a jury by the parties is by challenge, though in modern practice this course is seldom resorted to, having yielded to the more convenient usage of privately suggesting the objection to the officer who calls the jury in court; upon which the name objected to is passed over as a matter of course without discussion. This practice, though a far less troublesome and obnoxious mode of effecting the object of obtaining a jury indifferent between the parties than a formal challenge, is, strictly speaking, irregular, and being considered to take place by consent, and as a matter of favour, cannot be insisted upon as a right. Challenges are of two kinds: challenges to the *array*, and challenges to the *polls*. The challenge to the array is an objection to the whole panel or list of jurors returned for some partiality or default in the sheriff or the under-sheriff by whom it has been *arrayed*. Challenges to the polls are objections to particular jurors, either on the ground of incompetency (as if they be aliens, or of insufficient qualification within the provisions of the Jury Act, 6 Geo. IV., cap. 50), or of bias or partiality, or of infamy, as having been convicted of some crime which the law deems infamous. Upon these challenges the cause of objection must in each case be expressly shown to the court; but in trials for capital offences the accused is entitled to challenge *peremptorily* (that is, without giving any reason) thirty-five jurors. The king, however, as nominal prosecutor, has no right of peremptory challenge, though he is not compelled to show his cause of challenge until the panel is gone through, and unless a full jury cannot be formed without the person objected to.

The trial by jury, originally introduced into the law of France in criminal cases by the National Assembly, was retained in the French code. An account of the proceeding and of the qualifications and formation of the jury will be found in the 'Code d'Instruction Criminelle,' livre ii., tit. 2, chap. iv. and v. It has often been remarked as a singular fact, that the institution which in England has been highly prized as a security to the subject against the crown, should have been preserved in France by a despotic monarch, in the zenith of his power, and certainly not disposed to enlarge popular authority. The advantage of the trial by jury has been frequently the subject of debate among German and French jurists, and in particular the propriety of its introduction has been discussed in the various commissions issued with a view to reforming the laws of several of the German States.

Anciently in Scotland all offences were tried by juries; at present all prosecutions of a higher nature must proceed by an assize or jury of 15 men, who determine their verdict by a majority of voices. (Erskine's 'Principles of the Law of Scotland,' book iv. tit. 4.) In the course of many attempted improvements of the Court of Session, several efforts have been made to introduce the trial by jury into civil proceedings in Scotland; but great and general opposition has been made to it by the courts and the legal profession in Edinburgh. It cannot be said to have been fairly tried as yet, for no judges have been trained to its use, and no generation has had opportunity to learn how to act as jurymen. Whether the people of Scotland shall ever obtain the advantages of our English trial by jury, it seems difficult to say. Recent legislation on the subject, and recent observations in the House of Lords, have demonstrated that as an instrument in the administration of civil justice, trial by jury is not yet practicable in Scotland.

JUSTICE CLERK OF SCOTLAND, is now the second president of the Court of Justiciary in Scotland, being originally the clerk of court of the chief justice, or Lord Justice General of Scotland.

At the institution of the Court of Session in 1532, the justice clerk was made one of the judges. This will not surprise us when we consider the constitution of that court. It was essentially an ecclesiastical tribunal, and, agreeably to the practice of such, deliberated in secret with shut doors. It was necessary therefore for the security of the crown that some of the crown officers should be continually present. The justice clerk was one of these: he was public prosecutor on behalf of the crown. The king's treasurer was another; and accordingly both these were lords of session.

A further rise of official dignity took place: for it having become usual to appoint certain lords of session as assessors or assistant judges to the lord justice-general, the justice clerk began in the early part of the 17th century to be appointed to that duty; and about the middle of the same century he had acquired the style of "lord justice clerk." In ten years afterwards the privy council declared the justice clerk a constituent part of the justice court; and in 1672, he was made president of the Court of Justiciary, to preside in absence of the justice-general. His rise in the Court of Session followed; for in 1766, when Miller, afterwards Sir Thomas Miller of Glenlee, took his seat on the bench, it was, by desire of the court, on the right of the lord president; to which latter office he himself afterwards rose, being the first justice clerk so promoted. And in 1811, when the Court of Session, was, by 48 Geo. III., c. 151, divided into two chambers, the lord justice clerk was made *ex officio* president of the second division.

With respect to the *justice clerk depute*, that officer was long so termed; but when the justice clerk acquired the style of lord, and became a constituent part of the Court of Justiciary, his *depute* came to be termed "the principal clerk of justiciary," and this becoming a sinecure, he got himself a "depute" about the middle of last century, and the second depute in due course an "assistant;" all of whom, except the first sinecure office, the holder of which was a few years ago bought off by government, continue to this day, and are in the gift of the lord justice clerk.

Besides these there are three other justice clerk deputes, and his appointees. They are commonly called the "circuit clerks," being his deputies to the three circuits of the Court of Justiciary. They had their origin in the act 1587, c. 82, which directed such circuits to be made, in place of the former practice of the justiciar passing through the realm from shire to shire successively.

JUSTICE, LORDS, OF APPEAL IN CHANCERY. These judges, who are two in number, were created by the statute 14 & 15 Vict. c. 83, to assist the Lord Chancellor in the determination of appeals from the Master of the Rolls and Vice-Chancellors. They possess besides an original jurisdiction, so that when all the appeals are disposed of, they may hear causes in the first instance. The Lord Chancellor may sit with them, or separately, as a Court of Appeal. In Bankruptcy the Lords Justices constitute the Court of Appeal; in matters of lunacy they have, under the sign manual, the same authority as the Lord Chancellor.

JUSTICES, LORDS. Our kings have been, ever since the Conquest, in the habit of appointing, as occasion required, one or more persons to act for a time as their substitutes in the supreme government either of the whole kingdom or of a part of it. When William I. returned to Normandy, the year after the Conquest, he left his half-brother Odo, Bishop of Bayeux, and William Fitzherbert, to be *Custodes Regni*, or guardians of the realm, during his absence; and similar appointments were very frequent under the early Norman and Plantagenet kings. Down to the present time, indeed, similar officers have been appointed under various names, and with more or less extensive powers according to circumstances. Protector, lieutenant, or locum tenens, and regent, have been among the other names by which they have been known. Regents and councils of regency, during the nonage of the king or queen, have been sometimes named by the preceding possessor of the crown; but in modern times such arrangements have been usually made by statute. Coke remarks (4 'Inst.' 58) that the methods of appointing a guardian or regent have been so various, that "the surest way is to have him made by authority of the great council in parliament."

The most familiar case of the appointment by the crown of a representative to exercise the supreme executive power, not in a colony or dependency, is that of the appointment of the lord-lieutenant of Ireland, or of a council of government composed of lords justices.

The governor-general of Ireland under the crown has been styled at different times custos (keeper or guardian), justiciary, warden, procurator, seneschal, constable, justice, deputy, and lieutenant. Viceroy is a name of modern introduction. Formerly, upon the avoidance of the office by death or otherwise, the privy council there was authorised to elect a successor, with the restriction that he should be an Englishman and no spiritual person, who held office till the king appointed another. The ancient powers of this officer were almost regal; he performed every act of government without any previous communication with England; and when he left the country he even appointed his own deputy. From the Revolution, however, till the reign of George III., the lord-lieutenant resided very little in Ireland; in several instances the person appointed to the office never went over; in other cases he went over once in two years to hold the session of parliament; and the government was very often left in the hands of lords justices, without a lord-lieutenant at all. In modern times the appointment of lords justices for Ireland has only taken place on the occasional absences of the lord-lieutenant; and the lords justices have usually been the lord primate, the lord chancellor, and the commander of the forces.

In England lords justices and regents have been repeatedly appointed since the Revolution, on occasion of the king going abroad; and the appointment has usually, if not always, been made by letters patent, in the same manner as the lords-lieutenant or lords justices of Ireland have always been appointed. In some cases, however, the aid of parliament has been called in for certain purposes. When King William went over to Ireland, in 1689, he of his own authority appointed the administration of the government to be in the hands of the queen during his absence out of the kingdom, by declaration at the council-table; and at the same time an act was passed, 1 and 2 W. & M., s. 2, in the preamble of which his majesty's pleasure was recited, and it was enacted, that whensoever his majesty should be absent, it should be lawful for the queen to administer the regal power and government. This act was considered to be necessary, in consequence of the peculiar circumstances in which the queen was placed by the Act of Settlement, which had declared that the entire, perfect, and full exercise of the regal power and government should be only in and executed by his majesty in the names of both their majesties during their joint lives. It was at the same time provided, "That as often as his majesty shall return into this kingdom of England, the sole administration of the regal power and government thereof shall be in his majesty only, as if this act had never been made." After the queen's death lords justices were repeatedly appointed by the king.

One of the provisions of the statute of 12 & 13 W. III. (passed in 1700) for settling the succession in the House of Hanover, was, "That no person who shall hereafter come to the possession of this crown shall go out of the dominions of England, Scotland, or Ireland, without consent of parliament." This clause, however, was repealed in 1716, by 1 George I., stat. 2, c. 51. The repealing act was passed to gratify the king, whose "impatience to visit his German dominions," says Coxe in his 'Life of Walpole,' i. 77, "now became so great as totally to overcome every restraint of prudence and suggestion of propriety, and imperiously to demand indulgence." "The ministry," continues the historian, "were considerably embarrassed on this occasion, and drew up a strong remonstrance representing the inconvenience which would result from the projected journey. The remonstrance, however, not only failed of success, but so far exasperated the king, that he declared he would not endure a longer confinement in this kingdom.

It was thought more respectful to his majesty to obtain a repeal of the restraining clause at once, than to ask parliament merely for the leave of absence; and the bill passed through all its stages in both Houses without a dissenting voice, the Tories being favourably disposed to the principle, and the Whigs averse or frightened to offend the king. His majesty, who was at variance with his eldest son, now interposed another difficulty, refusing to intrust the government during his absence to the prince, without joining other persons with him in the commission, and also limiting his authority by the most rigorous restrictions. Upon this point, however, he yielded at last to the representations of the ministers, who concluded a long exposition of reasons against his leaving the kingdom at all at that crisis by stating that, "upon a careful perusal of the precedents, finding no instance of persons being joined in commission with the Prince of Wales" in the appointment of a regency, "and few, if any, restrictions upon such commissions," they were of opinion that the constant tenor of ancient practice could not conveniently be receded from. (Coxe, ii. 51–54.) Upon this the king submitted to give the prince the sole direction of affairs; "yet," says Coxe, quoting from the work called 'The Political State of Great Britain,' "he appointed him *Guardian of the Realm and Lieutenant*, an office unknown in England since it was enjoyed by Edward the Black Prince." In point of fact the title given to the prince in the original Latin commission was *Custos Regni nostri et Locum tenens*, which were the same words that had been commonly used in all such commissions down to the reign of Henry VIII., with this difference only, that one of the two titles (more frequently *Custos Regni*) was alone employed. The earliest use of the term *regent* appears to have been in the commission from Henry VIII. to Queen Katherine Parr, when he went over to Boulogne in 1544, in which she is styled *Rectrix et Gubernatrix Regni nostri*. Queen Mary, the wife of William III., whose case is the next that occurs, seems, as already stated, to have had no commission; and, being queen regnant in her own right, she was not even popularly styled regent.

When George I. went abroad, in May, 1719, he intrusted the government during his absence not to a regent, or any single person, but to thirteen lords justices, composed of the Archbishop of Canterbury and the principal officers of state. The commission begins by reciting that his majesty had "determined, for divers weighty reasons, speedily to go in person beyond the seas." The persons commissioned are appointed to be "our guardians and justices (*Justiciarii* must be the Latin term) of our said kingdom of Great Britain, and our lieutenants in the same, during our absence out of our said kingdom, or till further signification of our pleasure;" and they were authorised, four being made a quorum, "to execute the office and place of guardians, &c., and to order, do, and perform all and every act and acts of government and administration of government, and all other matters and things whatsoever, which, by virtue or reason of the aforesaid office or place, have been usual, or may be lawfully ordered, done, or performed." Power is afterwards specially given to keep the peace, to cause the laws and customs of the kingdom to be observed by all, to punish criminals, to hold the parliament then existing, to summon and hold other parliaments, to summon and hold the Privy Council; with the advice of the Privy Council, to issue proclamations, "and to do and perform all other things which have been usually done, or may be done, by us, by or with the advice of the same;" to appoint ambassadors, to make and conclude treaties; to confer, grant, and present to all benefices, to issue commands under the privy seal for and concerning the collection, levying, and disposal of the revenue; to command the army; to execute martial law in time of war, if that should happen; to command and employ the naval forces of the kingdom; to appoint to and discharge from all offices at the disposal of the crown; to grant pardons for high treason and all other crimes and offences; and finally, to do all these things in Ireland as well as in Great Britain.

The enumeration of the powers granted by this commission is probably the most authentic compendium that has been published of the functions of government ordinarily exercised by the crown. It does not, however, profess to be an enumeration of all the powers resident in the crown; and it may be observed, that besides, perhaps, some appertaining to the office of supreme head of the church, the power of creating peers and conferring honour is not made over to the lords justices. That is a power which, we believe, never has been delegated, or attempted to be delegated, if we except only the case of the patent granted by Charles I., in 1644, to Lord Herbert (better known as the Earl of Glamorgan), which, after the Restoration, he was compelled to resign by the interference of the House of Lords.

The Lords Justices are further required, in the execution of their powers, punctually to observe his majesty's pleasure, as it might be from time to time expressed in instructions signed by the royal hand; and the commission was accompanied by a set of instructions, twenty-one in number, the most important things directed in which are, that no livings or benefices in the gift of the crown which may become vacant shall be disposed of without his majesty's directions; that no orders or directions concerning the disposition of money shall be given before his majesty's pleasure shall have been signified thereupon; and that there must be no exercise of the power dissolving the parliament, or calling a new one, without special signification of the royal pleasure. The same restriction is put upon the exercise of the power of pardoning, and some of the other powers. In case however they should hold it necessary or expedient for the public service, the Lords Justices are authorised to fill offices immediately, and also to reprieve criminals; and they are permitted to continue the existing parliament by short prorogations, until they should be otherwise directed under the royal sign manual, and to summon the privy council to meet as often as they shall see occasion.

The government was in the same manner intrusted by George I. to lords justices when he again went abroad in 1720, 1723, 1725, 1727.

Queen Caroline, wife of George II., was so long as she lived always intrusted with the administration of the government when that sovereign went abroad. The 2 Geo. II. chap. 27, was passed in 1729, "To enable her majesty to be regent of this kingdom, during his majesty's absence, without taking the oaths;" on the 15th of May thereafter, according to Salmon's 'Chronological Historian,' a commission passed the great seal constituting her guardian and lieutenant of the kingdom during the king's absence; and the same authority states her to have been appointed guardian in 1732, and regent on the two other occasions. A patent, with the like powers as that issued to the Prince of Wales in 1716, passed in 1732, appointing Queen Caroline guardian and lieutenant of the kingdom in the king's absence. Most probably all the four appointments were made in the same manner and in the same terms. After the death of Queen Caroline, the government was always left during the reign of George II. in the hands of lords justices when the king went abroad; the commissions and the accompanying instructions being on all occasions nearly the same with those issued in 1719.

George III. during his long reign never left England. When George IV. went to Hanover, in September, 1821, nineteen guardians and lords justices were appointed, the Duke of York being the first. "One good effect arose from their appointment, that the lords justices during his (the king's) absence signed an immense number of military commissions and other documents, which had been accumulating since his accession to the throne." ('Morning Chronicle,' Aug. 11, 1845.) The writer of the newspaper article here quoted contends that "the royal authority of an English monarch cannot be personally exercised in a foreign country." "We take it," he adds, "to be quite clear, that a patent sealed with the great seal in a foreign country would be void. To guard against any such irregularity, the law requires that the patent shall state the place where it is signed and sealed as *apud Westmonasterium*."

Nevertheless, no provision such as had been customary on such occasions has been made for the exercise of the royal authority when her present majesty has temporarily left the kingdom. On one occasion the subject was (for what object does not appear) brought forward in the House of Lords by Lord Campbell, who, after stating at some length the course which he maintained had been uniformly taken down to the year 1843, asked if it was the intention that lords justices should be now appointed? The lord chancellor replied that the government had no such intention. "On the occasion of her majesty visiting the King of the French," his lordship is reported to have said, "the then law officers of the crown, the present lord chief baron and the late Sir William Follett, had been consulted. . . . . And after mature deliberation, these learned persons gave it as their decided opinion that it was not at all necessary in point of law that such an appointment should take place. . . . . In the present instance, also, the law officers of the crown had been consulted as to whether it was necessary in point of law for her majesty to appoint a regency during her absence, and their reply was that it was in no degree necessary; an opinion in which he entirely concurred."

It ought to be mentioned that the seven persons appointed in 1705 by the 4 & 5 Anne, c. 8, and again in 1707, by the 6 Anne, c. 7, to administer the government along with other persons whom the new king or queen should have named, in case of his or her absence at the time from the kingdom, are styled lords justices in the act, although called regents by Burnet, and in the common accounts. These lords justices (twenty-six in all) who actually came into office on the death of Queen Anne, 1st August, 1714, and continued till the arrival of the king on the 18th of September, enjoyed more extensive powers than any others that have been appointed, at least in modern times. They were authorised to execute all powers of government, in as full and ample manner as the next successor could use or execute the same if she or he were present in person within this kingdom of Great Britain, until such successor should arrive, or otherwise determine their authority. The only restrictions laid upon them were, that they were not, without direction from the "queen or king," to dissolve parliament; and that they would subject themselves to the pains of high treason if they gave the royal assent to any bill or bills for repealing or altering the Act of Uniformity, or the Act for the Establishment and Maintenance of the Presbyterian Church Government in Scotland.

The most important of the facts we have stated have been derived from the report of the committee appointed by the House of Commons in 1788, "to examine and report precedents of such proceedings as may have been had in the case of the personal exercise of the royal authority being prevented or interrupted by infancy, sickness, infirmity, or otherwise," which is printed in the Journals of the House, vol. xliv., pp. 11-42. And some particulars may be gleaned from the accounts of the proceedings in the two Houses of Parliament on occasion of the king's illness in 1788, as reported in the 'Parliamentary History,' vol. xxvii., pp. 653-1297; and from the discussions on the Regency Bill from the beginning of November, 1810, to the middle of February, 1811, which nearly fill the 18th volume of the 'Parliamentary Debates.' One of the speeches which attracted most attention on the latter occasion for its argument and research (that delivered by John Leach, Esq., afterwards vice-chancellor) was published in an authentic form, and may on this subject be usefully consulted.

JUSTICES OF THE PEACE are persons appointed to keep the peace within certain prescribed limits, with authority to act judicially in criminal causes, and in some of a civil nature arising within those limits, and also to do certain other things in which they act not judicially but ministerially, that is, as servants of the crown performing official acts in respect of which they are entrusted with no judicial discretion. The authority of justices of the peace is derived from the king's prerogative of making courts for the administration of the law, or created by different statutes; their duties are expressed in the royal commission appointing them to the office, or are prescribed by those statutes.

Before the reign of Edward III. there were in every county conservators of the peace, whose duty it was to afford protection against illegal force and violence. These conservators were chosen by the freeholders assembled in the county court under the king's writ.

The lord chancellor, the judges of the king's bench, and every sheriff and coroner, were conservators, and are now justices of the peace, by virtue of their office; and some lands are holden under the service annexed to the tenure of such lands of being conservators of the peace, or of providing fit persons to perform the duties of that office. High and petty constables are also by virtue of their offices conservators of the peace. The authority of conservators of the peace at the common law was the same as that now exercised by constables within their respective townships; and their duty consisted in acting themselves, and commanding the assistance of others, in arresting and quieting those who in their presence and within the limits of their jurisdiction went about to break the peace.

The following account is generally given of the origin of the present justices of the peace. Upon the compulsory resignation of Edward II., Edward III., or rather his mother Isabella, in his name, sent writs to the different sheriffs, stating that his accession had taken place with his father's assent, and commanding that the peace should be kept on pain of disinheritance and loss of life and limb. Within a few weeks from this time it was ordained, by 1 Edward III., stat. 2, c. 16, that for the better keeping and maintaining of the peace in every county, good and lawful men who were not maintainers of barretry (malveiz barrets) should be assigned to keep the peace. The mode in which these new keepers of the peace were to be assigned was construed to be by the king's commission; and this ordinance had the double effect of transferring the appointment from the people to the crown, and of laying a foundation for the gradual accession of those powers which are now exercised by justices of the peace.

By 12 Richard II., c. 10, the wages of justices of the peace were fixed at four shillings per day of sessions, and two shillings for their clerks, payable out of the fines and amerciaments at such sessions; but these wages, like those of members of parliament, have long ceased to be received, and the provisions respecting them were repealed by the stat. 18 & 19 Vict. c. 126.

Justices of the peace are appointed either by act of parliament, by royal charter (in the case of justices in boroughs not within the Municipal Corporation Act the charter usually appointing certain municipal officers to be justices, and prescribing the manner in which vacancies in the offices are to be filled up), or by a commission from the crown under the statute of 1 Edward III. The form of the commission of the peace has from time to time been altered, and the authority of the justices enlarged. As now framed it consists of two distinct parts, and contains two separate assignments or grants of authority. Of these the former gives to any one or more justices not only all the power relating to the maintenance of the peace which was possessed by the conservators at common law, but also all the additional authority mentioned in the statutes. The latter assignment defines the power of justices when the whole body, or such of them as choose to attend, act together in general sessions. [SESSIONS.]

By 5 Geo. II., c. 18, no attorney, solicitor, or proctor shall be a justice of the peace for any county whilst he continues in practice, and a similar provision is contained in the 6 & 7 Vict., c. 73, s. 33. By 18 Geo. II., c. 20, no person shall be capable of acting as a justice of the peace for any county, riding, or division, within England or Wales, who shall not have, in law or equity, to and for his own use and benefit, in possession a freehold, copyhold, or customary estate for life, or for some greater estate, or an estate for some long term of years determinable upon life or lives, or for a certain term originally created for twenty-one years or more, in lands, tenements, or hereditaments in England or Wales, of the clear yearly value of 100*l.* over and above all incumbrances affecting, and all rents and charges payable out of or in respect of the same, or who shall not be seised of or entitled to, in law or equity, to and for his own use and benefit, the immediate reversion or remainder of and in lands, tenements, and hereditaments, leased for one, two, or three lives, or for any term of years determinable on lives upon reserved rents, and which are of the yearly value of 300*l.*, and who shall not have taken and subscribed an oath stating the nature of the qualifying estate. The third section of this statute imposes a penalty of 100*l.* upon those who act without having taken and subscribed the oath, and for acting without being qualified. The statute, however, excepts from these provisions certain official persons, &c., and other exceptions have been since introduced. Thus the judges of the County Court may sit without the qualification (9 & 10 Vict., c. 95, s. 21.) A justice of the peace cannot legally act after he has ceased to be qualified; but it is not necessary that he should continue to retain the same qualification, nor will the absence of a qualification render his acts absolutely void.

Justices appointed by Act of Parliament or by the king's charter are not removable except for misconduct, but the authority of a justice appointed by the king's commission may be determined at the pleasure of the crown, either directly by writ under the great seal, or impliedly, by making out a new commission, from which his name is omitted. But until notice of the revocation of the authority, or publication of a new commission, the acts of the ex-justice are valid in law, and the warrant of a justice remains in force until it be executed, although he die before its execution. The commission is also determined by the death of the king by whom it was issued; but by 6 Anne, c. 7, s. 8, all offices, civil and military, are to continue for six months after the demise of the crown, unless sooner determined.

The 9 Geo. IV., c. 17, repeals the statutes which imposed the taking the sacrament of the Lord's Supper as a qualification for office, and requires the following declaration:—"I, A B, do solemnly and sincerely, in the presence of God, profess, testify, and declare, on the true faith of a Christian, that I will never exercise any power, authority, or influence which I may possess by virtue of the office of justice of the peace, to injure or weaken the Protestant church as it is by law established in England, or to disturb the said church, or the bishops and clergy of the said church, in the possession of any rights or privileges to which such church or the said bishops or clergy are or may be entitled." The omission to subscribe this declaration does not subject a person acting as a justice of the peace to any penalty; the statute (s. 5) merely renders the appointment void; and whilst the justice continues in the exercise of his office his acts are not either void or voidable so as to affect the rights of those who are not privy to such omission.

The judicial authority of a justice out of sessions is both civil and criminal: civil, where he is authorised by statute to adjudicate between master and servant, or to enforce the payment of rates, tithes, &c.; criminal, where he requires surety of the peace or a recognisance for the peace or for good behaviour, or where he acts in the suppression of riots, or where he acts with summary power to decide upon the guilt or innocence of the party accused, according to the view which he may take of the evidence, and to punish the offender. But all proceedings before justices, whether civil or criminal, if removed into the Queen's Bench, are there treated as belonging to the crown side of the court.

By two Acts of Parliament (11 & 12 Vict. cc. 42 & 43), commonly called 'Jervis's Acts,' repealing various earlier statutes, the duties of justices of the peace out of sessions (that is, when not assembled in quarter or general sessions for the county) in England and Wales are facilitated and defined. The one statute (c. 42) relates to the duties of justices out of sessions with respect to persons charged with indictable offences, and the other (c. 43) to summary convictions and orders.

Under the former statute, where a charge or complaint is made before a justice, that any person has committed, or is suspected to have committed, any treason, felony, or indictable misdemeanor, or other indictable offence whatsoever within the limits of the jurisdiction of the justice, or that any person guilty, or suspected to be guilty, of having committed any such crime or offence elsewhere, is residing within such jurisdiction, the justice may issue a warrant under seal directed to peace officers for his apprehension, founded on information on oath (or a summons not founded on oath in the first instance, followed by a warrant if disobeyed). Upon the accused person being brought before the justices, they must, before committing him to prison for trial or admitting him to bail, in his presence (but in open court or privately, at their discretion), take the statement on oath of the witnesses (to compel the attendance of whom justices have power to issue summonses and warrants), and reduce the evidence into written depositions, to be signed by the witnesses. These depositions are read over to the accused, and his own statement (if any) taken in a prescribed form, so as to exclude any threat or inducement. Ample powers are given to the justices to remand, dismiss, commit for trial, or hold the accused to bail, and to bind over prosecutors and witnesses by recognisance.

By more recent statutes, instead of committing for trial, justices may summarily convict (unless the accused prefers to be tried by a jury) in trifling cases of larceny, or where the offenders are under sixteen. (See 10 & 11 Vict. c. 82; 18 & 19 Vict. c. 126; 19 & 20 Vict. c. 118; and Blackstone's 'Commentaries,' by Kerr, vol. iv., p. 333.) Justices may also issue warrants to apprehend parties against whom indictments have been already found, and without further inquiry commit them for trial or admit them to bail, or, if already in prison, may order their detention.

The 11 & 12 Vict. c. 43, relating to summary convictions, empowers the justices to issue a summons; or, for any offence punishable on conviction, they may issue a warrant (founded on an information on oath) in the first instance. If a summons be issued in the first instance (and this is the general mode of proceeding), and it is not obeyed, the justices may either issue a warrant or proceed *ex parte*. When, however, the application for any order of justices is by law to be made *ex parte*, there is no necessity for issuing any summons. In cases of complaints upon which the justices may make an order for payment of money or otherwise, it is not necessary that the complaint should be in writing. There is similar power to compel the attendance of witnesses, as in cases of indictable offences. Every complaint and information is heard and determined by one or more justices (unless any particular Act requires more than one) in open court, and both parties may appear by counsel or attorney. General forms of convictions and orders are given, to prevent the numerous technical objections to which they were previously often open. The convictions or orders may be enforced by distress, or imprisonment in default (see also 21 & 22 Vict. c. 73, s. 5), or, in the first instance, according to the nature and circumstances of the case and the special provisions relating to it. The justices have also general powers to award costs, which are also recoverable by distress and imprisonment in default.

In matters relating to the revenue, or to the poor, and to certain other things, the special provisions of the statutes on those subjects are to be followed by the justices.

In cases of summary convictions and orders, parties dissatisfied with the decision of justices in point of law may require them to state a case for the opinion of any one of the three superior courts of common law (20 & 21 Vict. c. 43); and this power is very extensively acted upon.

Power has been expressly given to justices to direct the prosecution for perjury of witnesses before them. (14 & 15 Vict. c. 100, s. 19.)

Justices of the peace have in general no authority over matters arising out of the county or place for which they are appointed, and therefore their warrants can in general only be executed by apprehending the offender within the jurisdiction of the justice, except in case of "fresh pursuit," at any place within seven miles of the border. But when the person is not found, or has escaped, any justice of the county where he is supposed to be, may give effect to the original warrant by an indorsement authorising its execution within his own jurisdiction. This, which is termed "backing the warrant," is done upon proof of the handwriting of the justice who issued it; and the person, when apprehended, is then taken before the justice who issued the warrant, unless the prosecutor or any of the witnesses may be in the county where the apprehension takes place, in which case the examinations may proceed there. This power to back warrants is not confined to the case of counties, but English warrants may be backed in Ireland, Scotland, or the Isle of Man and Channel Islands (see 14 & 15 Vict. c. 55, s. 18), and *vice versâ*.

In the case of indictable offences committed on the high seas or abroad, warrants may be issued by justices of the county or place where the offender may be.

So, although justices of the peace when they are out of the county, &c., for which they are appointed have in general no coercive power, yet where a justice is also a justice for an adjoining county he may act for and deal with offenders in one county while in the other. So, also, a justice for a county may act in any city, town, or precinct within or adjoining to it; and there are similar provisions with respect to detached parts of counties. The powers of metropolitan police magistrates and of stipendiary magistrates are regulated by special statutes and provisions.

Justices ought not to exercise their functions in cases in which they are themselves the persons injured. They should cause the offenders to be taken before other justices, or, if present, should desire their aid.

When justices refuse to hear a complaint over which they have jurisdiction, or to perform any other duty which the law imposes on them, the party aggrieved by such refusal may apply to the court of Queen's Bench for a rule (founded upon an affidavit of the facts) calling upon the justice and the parties interested to show cause why the act required (11 & 12 Vict. c. 44, s. 5) should not be done. This is a more expeditious and cheaper mode of proceeding than the former mode by mandamus; and, moreover, the order of the court to do any act, protects the justice, which a mandamus did not. [MANDAMUS.]

Justices of the peace are strongly protected by the law in the execution of their office. Opprobrious words which would not subject the speaker to any proceeding, civil or criminal, if uttered under other circumstances, yet if spoken of a justice whilst actually engaged in his official duties may be made the subject of an action or of an indictment, or if spoken in the presence of the justice may be punished by commitment to prison as for a contempt of court.

Where a justice of the peace acting in or out of sessions acts judicially in a matter over which he has jurisdiction, and does not exceed his jurisdiction, he is not liable to an action however erroneous his decision may be; nor will even express malice or corruption entitle a party aggrieved by such decision to any remedy by action: the delinquent magistrate is answerable only to the crown as for an offence committed against the public. Where the justice has no jurisdiction or exceeds his jurisdiction, or having jurisdiction deviates from the prescribed legal form to an extent which renders the proceedings void, or where a conviction under which the justice has granted a warrant is set aside by a superior court, an action will lie against the justice to recover damages in respect of any distress, imprisonment, or other injury which may have resulted from his acts, though done without malice or other improper motive. But even in these cases, if the justice has acted *bonâ fide* in his magisterial capacity, if he has intended to act within his jurisdiction, though by mistake he may have exceeded it and not acted within the strict line of his duty, and also in cases where a justice has acted or intended to act in the execution of his ministerial duties, he is entitled to the protection of several important statutory regulations, though where there is no colour whatever for a belief or supposition on the part of the justice that he is acting within his jurisdiction, where the act is wholly alien to the magisterial functions and done *diverso intuitu*, these regulations do not apply.

By the 11 & 12 Vict. c. 44 (another of 'Jervis's Acts'), reciting that it is expedient to protect justices of the peace in the execution of their duty, and repealing various previous provisions from the reign of James I., having the same object, no action brought against a justice of the peace for any act done by him in the execution of his duty with respect to any matter within his jurisdiction, can be maintained unless it be proved that the act was done maliciously, and without reasonable and probable cause: and with respect to acts done by a justice in a matter of which by law he has not jurisdiction, or in which he has exceeded his jurisdiction, if done under a warrant or colour, no action can be maintained until the conviction or order has been quashed; and no action can be brought after a conviction or order confirmed on appeal. If it be proved that the plaintiff was actually guilty of the offence, he cannot recover more than twopence damages without costs. Every action against a justice must be commenced within six months, and one month's notice of action must be given. Wherever a discretionary power is given to a justice, no action is maintainable by reason of the manner in which that discretion has been exercised.

When a justice acts with partial, corrupt, or malicious motives he is guilty of a misdemeanor, for which he may be indicted, and in a clear case of misconduct the Court of Queen's Bench, which exercises a general superintendence over the conduct of those to whom the administration of the criminal law of the country is entrusted, will, if the application be made without delay, give leave to file a criminal information. But the court will consider, not whether the act complained of be strictly right or not, but whether it proceeded from unjust, oppressive, or corrupt motives, among which motives fear and favour are both included. If the affidavits filed in support of the application disclose nothing which may not be attributable to mere error or mistake, the court will not even call upon the justice to show cause why a criminal information should not be filed. The court will not entertain a motion for a criminal information against a justice of the peace, unless notice of the intended application have been given in sufficient time to enable him, if he thinks proper, to meet the charge in the first instance by opposing the granting of the rule to show cause.

The proceedings after an information has been filed or an indictment found against justices of the peace for criminal misconduct are the same as in other cases of misdemeanor. If the defendant suffer judgment by default, or is found guilty by the verdict of a jury, the punishment is by fine or imprisonment or both; after which an application may be made to the lord chancellor to exclude him from the commission; and when affidavits are filed in the Queen's Bench impeaching the conduct of justices of the peace, such affidavits are sometimes directed by the court to be laid before the chancellor, to enable him to judge whether such persons ought to remain in the commission.

The institution of justices of the peace has been adopted in most of the British colonies, and has with some modifications been retained in the United States of America.

JUSTICIAR OF SCOTLAND. The earliest individual in this high office which extant records name seems to be Geoffrey de Maleville, of Maleville, in the county of Edinburgh, *temp.* Malcolm IV.

The term "Scotland" was then less extensive in its application than at present; it designated, properly speaking, not the whole territory of the realm, but that part only which lay north of the Forth, or *Scots sea*, as it was called; and accordingly, contemporary with Maleville there was another justiciar, David Olifard, justiciar of Lothian, that is to say, the territory south of the Forth, excepting the district of Galloway, which had long its own peculiar laws and customs. About the middle of the 13th century, however, Galloway too had its justiciar, so at this time there were *three* justiciars in the realm of Scotland—a justiciar of Galloway, a justiciar of Lothian, and a justiciar of Scotland strictly so called. They were all probably of co-ordinate authority: each, next to the sovereign, supreme in his district; but the district of the last was the most extensive, and, containing within it the metropolis of the kingdom, it was also no doubt the most important and the most coveted. The justiciars of Scotland were accordingly the most conspicuous men of the time:—the Comyns, earls of Buchan; the MacDuffs, earls of Fife; Melville; and Sir Alan Durward. This last had an eye to the crown itself, for having married the illegitimate daughter of King Alexander II., he gained over the chancellor to move in council her legitimation, and that, on failure of issue of the king's body, she and her heirs might inherit her father's throne. But the king conceived so great a displeasure at this, that he immediately turned the chancellor out of office, and soon afterwards the justiciar also. The proud

Durward removed to England, joined King Henry III. in France, and served in his army, till in a few years he was, by the influence of the English king, restored to his office of justiciar, whence he was displaced only by the more powerful Comyn. The incident in Durward's life to which we have just alluded, was not singular: the justiciar was *caput legis et militiæ*, at the head both of the law and also of the military force of the kingdom, and repeated instances occur in early times of their military prowess as well as judicial firmness.

The death of King Alexander III. left the crown open to a competition which allowed Edward I. of England to invade the kingdom. In 1292 the English Court of King's Bench sat for some time in Roxburgh; and in 1296, Sir William Ormesby, a justice of the Common Pleas and justice in eyre in England, was constituted, by Edward, lord justiciar of Scotland. This appointment was of short duration; but in 1305, Edward, having again put down the Scots, distributed the kingdom into four districts, and constituted for each district two justices (an Englishman and a Scotchman), in the nature of the English justices of assize—with a view to put the whole island under one and the same judicial system. Edward's early death, however, rendered the scheme abortive; and Galloway had soon its own laws, and Lothian and Scotland their justiciars as before, with this difference, that the metropolis of the kingdom was now shifting southwards to Edinburgh, and the term Scotland, in its strict acceptation, had given place to the appellation "north of the Forth." Sir Hugh de Eglinton, justiciar of Lothian in the middle of the 14th century, and distinguished for his poetical genius, was now therefore "Hugh of the Awl Ryal," or of the royal palace; and towards the end of the next century Andrew, Lord Gray, was advanced from the situation of Justiciar North of Forth to that of Justiciar South of Forth. He continued in this place with approbation for eleven years, and died but a few months before the calamitous affair of Flodden.

On this event, which happened in the beginning of the 16th century, the office of lord justiciar, or, as he was now styled, justice-general (in contradistinction to the special justiciars, now frequently appointed as well for particular trials as for particular places and districts), came into the noble family of Argyle, where it was hereditary for a century, and comprehended at once the entire kingdom. The High Court of Justiciary then also began to be settled at Edinburgh, and the regular series of its records, or books of adjournal, to commence. It was at this time also that the Court of Session was erected by ecclesiastical influence. Various attempts had been made by the clergy in former reigns to establish such a court. In 1425 the first "Court of the Session" was instituted under the influence of Wardlaw, bishop of St. Andrew's, and founder of the university there; but immediately on his death, which happened soon after, it drooped and expired. In 1458 Bishop Shoreswood, the king's secretary, tried to revive it; and about thirty years after, Elphinstone, Bishop of Aberdeen, did so likewise. In 1494, however, the latter founded, or rather re-founded, the university of Aberdeen, and had interest enough to get an act passed in parliament to enforce in all the courts of the kingdom the study and practice of the Roman laws; and in 1503 the "Court of Daily Council" was established. This court had a more extensive jurisdiction than the former; it was universal, being instituted to decide all manner of summonses in civil matters, complaints, and causes daily as they happened to occur; and it was calculated to be permanent. But the present was not an opportunity to be lost; and accordingly, in the minority of King James V. and while the nation was weakened and distracted by the loss at Flodden, the Court of Session was established under the lord chancellor, and with a majority of ecclesiastics both on its bench and at its bar. The consequence was, that from that day forward the Court of Justiciary declined; its civil jurisdiction ceased, being engrossed by the Court of Session; and the latter became in its place the supreme court of the kingdom. The Reformation effected a change in the composition of the Court of Session, but not much in its position or powers; and in 1672 an act was passed in parliament constituting a certain number of the judges, or lords of session, judges of justiciary under the justice-general and justice-clerk, who was now made vice-president of the Court of Justiciary.

Nothing else of consequence touching the constitution of the court occurred till, by 1 Will. IV., c. 69, s. 18, the office of lord-justice-general, which had become in a manner a perfect sinecure, was appointed to devolve on and remain with the office of lord-president of the Court of Session, who should perform the duties thereof as presiding judge in the Court of Justiciary. The effect of this enactment was to place the lord-justice-general again at the head of the administration of the law; and thus, by a singular revolution, restore him, after the lapse of 300 years, to his former situation of lord-chief-justice of Scotland.

JUSTICIARY, CHIEF, of England (*Capitalis Justitiarius Angliæ*). None either of the English lawyers or legal antiquaries who have handled this subject have given at all a satisfactory explanation of it. In order to comprehend the functions of the great officer, it is necessary first to understand those of "The *Grand Seneschall*, or *Dapifer—Senescallus*, or *Dapifer Angliæ*: in modern phraseology, the lord high steward—*comes palatii*, *major domus regiæ*, or *maire du palais*. The word *seneschalch*, about the etymology of which opinions vary somewhat, meant originally a sort of steward in the household of the Frank kings. After their conquest of Gaul, it came to signify a high political dignity. Dapifer means the same thing, being the Latin synonyme for it. This officer was the highest in the state after the king, executing all the chief offices of the kingdom as the king's representative. He was not only at the head of the king's palace, but of all the departments of the state, civil and military, chief administrator of justice, and leader of the armies in war. This is proved not only to have been the case in France, by Ducange and other high authorities, as well as by the public records of that kingdom, but to have been so also in England, by a document published by Madox, from the black and red books of the Exchequer, the celebrated 'Dialogus de Scaccario,' written in the time of Henry II.; and likewise by certain MSS. preserved in Sir Robert Cotton's collection in the British Museum, particularly an old MS. entitled 'Quis sit Seneschallus Angliæ, et quid ejus officium.'" ('Pict. Hist. Eng.' i. 567.)

By the nature of the feudal system everything had a tendency to be given in fief. Among other things, the office of seneschal was given in fief too, and became hereditary among the Franks, Normans, and at the conquest of England, among the Anglo-Normans. In France, under the Merovingian dynasty, the office was in the family of Charles Martel, from whom sprung the Carlovingian dynasty; afterwards the Plantagenet counts of Anjou were hereditary seneschals of France; and in England this high office was granted by William the Conqueror to the Grantmesnils, and thence came by marriage to the earls of Leicester. After the attainder of the family of Montfort, earl of Leicester, the office was given to Edmund, the second son of king Henry III., and it then remained in the royal family till its abolition—Thomas Plantagenet, second son of king Henry IV., being the last permanent high steward, the office being conferred afterwards only *pro unicâ vice*.

In France, when the office became hereditary in the counts of Anjou, it soon became necessary, for various reasons, to have another seneschal, or dapifer, besides the hereditary one; and this officer, whether he be considered as the representative or deputy of the hereditary seneschal, still took precedence, as appears from the charters of the French kings, of all the other great officers of state. In England also something of the same kind took place, but with this difference—that the various functions of the original grand seneschal, or *senescallus Angliæ*, were divided into two parts, and committed to two distinct officers as his representatives: the judicial functions being committed to an officer styled the High, or rather Chief Justiciary; the administrative and those relating to the affairs of the king's palace or household, to an officer styled, *not* the Senescallus *Angliæ*, but the Senescallus, or Dapifer *Regis*. This explanation will be found to completely remove the confusion that has so long prevailed among the English historians, antiquaries, and lawyers on this subject. And this view of the subject, if it needed it, would be corroborated by the high privileges of the officer created in later times, to preside in the House of Lords at state trials, which officer, be it observed, is not "high justiciary," but "lord high steward," that is "*Senescallus Angliæ*." This explanation also removes the difficulty of accounting for the extraordinary powers of the lord high steward's court, which some English lawyers have attempted to get over by saying that the lord high steward succeeded to some of the powers of the high justiciary, whereas he merely exercises powers which he had delegated to the high justiciary.

The chief justiciary was usually, even in those times, when, from the circumstance of the king and the great officers of his household acting as judges, we may conclude that a special education was not considered absolutely necessary to fit a man for the judicial office, a person who had given particular attention to the study of jurisprudence. As the representative of the judicial portion of the grand-seneschal's power, his authority extended over every court in the kingdom. For as to what Blackstone says of the court of the marshalsea, that is, the court of the lord steward of the king's household, having never been subject to the jurisdiction of the chief justiciary and no writ of error lying from it to the king's bench, it merely amounts to this, that the court of the lord steward was in fact originally the court of the lord high steward, and in that court either of his representatives, the chief justiciary or the lord steward, might preside.

The chief justiciary not only presided in the king's court and in the exchequer, but he was originally (or rather when the lord high steward fell into abeyance, partly from dread of his power and partly from the impossibility of securing an hereditary succession of the qualities necessary to fulfil his great and numerous duties), by virtue of his office, regent of the kingdom during the king's absence; and at those times writs ran in his name, and were tested by him. And in this light the chief justiciary is regarded as having been the greatest subject in England. One of the most distinguished men who held this high office was Ranulph de Glanville, who is usually regarded as the author of the 'Tractatus de Legibus et Consuetudinibus Angliæ,' the oldest book extant on English law.

The last who held the office and bore the title of *Capitalis Justitiarius Angliæ* was Philip Basset: and the first who held the office of *Capitalis Justitiarius ad placita coram Rege tenenda*, that is, chief justice of the king's bench, was Robert de Bruis, appointed in the fifty-second year of Henry III. Sir Edward Coke was fond of indulging his vanity by bestowing the same title, "Chief *Justice* of England," upon himself and on the Grand Justiciary, the mighty *Capitalis*

Justitiarius Angliæ; which was noticed by Lord Chancellor Ellesmere in his address to Sir Henry Montague, Coke's successor, upon his being sworn in chief justice, in these words:—"instead of containing himself within the words of the writ to be the chief justice, as the king called him, 'ad placita coram nobis tenenda.'"

JUSTICIARY COURT in Scotland. The High Court of Justiciary is the supreme criminal court in Scotland. It consists of the lord justice general, lord justice clerk, and five other judges of the Court of Session, and sits at Edinburgh, from time to time during the year, according to the extent of business to be transacted. Offences committed in Edinburgh and within the district of the Lothians are tried before this court, and in cases where in other parts of the country waiting for the next Circuit Court would create too much delay, or where there is any other ground of expediency, the trial may proceed before the Central Court. Other trials in the provinces proceed before the circuit courts, which are held in spring and autumn, each by two judges, or as they are termed Lords Commissioners of Justiciary. The southern circuit is held at Jedburgh, Ayr, and Dumfries; the western, at Glasgow, Inverary, and Stirling; and the northern at Perth, Aberdeen, and Inverness. An additional circuit is held at Glasgow in winter. Questions may be *certified* from the circuit courts to the High Court of Justiciary, that is to say, before being decided the matter may be reserved for the consideration of that court. But it is a peculiarity both of the central and circuit courts of Justiciary, that no decision once given can be reconsidered either by the court pronouncing it or a Court of Review. This principle is liable to many objections; and is productive of but one benefit, that no trial is thrown away by the subsequent discovery of flaws in initial procedure. Before the case goes to a jury, a judgment is pronounced "finding the indictment relevant," and virtually declaring the initial procedure regular; that the charge is properly laid, and the offence if proved punishable. Any objections to the regularity of the proceedings must therefore be stated before judgment, which when once pronounced is final. All cases before the Court of Justiciary are tried by a jury of fifteen, a majority returning the verdict where they are not unanimous. It has jurisdiction in all the more serious offences except high treason, which can only be tried under a commission of Oyer and Terminer, in which English judges would now probably be included.

JUSTIFIABLE HOMICIDE. [MURDER.]

JUSTIFICATION is used in theology to signify the acceptance of a sinner by God, and is frequently employed by the sacred writers as equivalent to the forgiveness of sin. Thus, St. Paul says, "Be it known unto you therefore, men and brethren, that through this man is preached unto you the forgiveness of sins, and by him all that believe are justified from all things, from which ye could not be justified by the law of Moses." (Acts, xiii. 38, 39.) The Protestants and Roman Catholics differ respecting the signification that should be attached to the word justification. The former maintain that the Hebrew word הַצְדִּיק, and the Greek words *δικαιοῦν* and *δικαίωσις*, are almost invariably employed in the Bible in a judicial sense; that is, to declare a person righteous notwithstanding the sins he has committed, and to deliver him from the punishment which his sins had deserved. The latter interpret the words in a physical sense; and maintain that to be justified is not to be reckoned righteous by God, but actually to be made righteous by the infusion of a sanctifying principle. The Protestants, on the contrary, believe, that though sanctification is a consequence of justification, yet it is a distinct and separate operation.

The reason or cause of our justification is generally divided by theologians into the originating, the meritorious, and the instrumental, cause, or the *causa efficiens*, the *causa meritoria*, and the *causa apprehendens*.

1. The *Originating cause* is the love of God towards his fallen creatures (Rom. iii. 24; Eph. ii. 8). 2. The *Meritorious cause* is, according to the 11th article of the Church of England, and the opinion of most Protestants, "the merit of our Lord and Saviour Jesus Christ, and not our own works or deservings" (Rom. iii. 25; v. 18; Eph. i. 7; Col. i. 14); but the Roman Catholic church maintains that good works, penances, and the intercession of saints also contribute to our justification. 3. The *Instrumental cause* is faith in the vicarious sacrifice of Christ; since the merit of Christ's sacrifice does not produce our pardon, unless we believe in its efficacy.

The consequences of justification are said to be: 1. Peace with God (Rom. v. 1); 2. Tranquillity of conscience; 3. Adoption of the persons justified into the family of God (Rom. viii. 14–17); 4. Spiritual joy, arising from the belief of our being adopted by God ('Rom.' xiv. 17); 5. The hope of eternal life.

JUSTINIAN'S CODE, or LEGISLATION. Justinian, soon after ascending the throne, gave orders (Feb. A.D. 528) to a commission consisting of Joannes and nine other persons, among whom were Tribonian and Theophilus, to make a general compilation of the best and most useful laws, or "constitutions," which had been promulgated by the emperors his predecessors, beginning from Hadrian's perpetual edict down to his own time. [CONSTITUTIONS, ROMAN.] Partial compilations had been made in the time of Constantine by private individuals, Gregory and Hermogenes, of which only fragments remain, and a more complete one was effected under Theodosius II. [THEODOSIAN CODE.] All these were now merged in the new code of Justinian. Joannes and his nine associates completed their task in fourteen months, and the new code, having received the imperial sanction, was published in April, A.D. 529. A few years after, Justinian, by the advice of Tribonian, ordered a revision of his code to be made by Tribonian and four others. The commissioners suppressed several laws, as either useless or inconsistent with present usage, and added many constitutions which the emperor had been promulgating in the mean time, as well as fifty decisions on intricate points of jurisprudence. The code thus revised was published in December of the year 534, under the title of 'Codex Justinianeus repetitæ prælectionis,' and thenceforth had the force of law.

The Code is divided into twelve books; every book is subdivided into titles, and each title into laws. Book i. treats of the Catholic faith, defines its creed agreeably to the first four general councils, forbidding public disputations on dogmas; it then treats of the rights, privileges, and discipline of bishops and other ecclesiastical persons; next of heretics, Samaritans, Jews, apostates, &c., against whom it contains several penal enactments; after which the book proceeds to speak of the laws, and their different kinds, and lastly of the magistrates. Book ii. treats of the forms to be observed in commencing a suit; then of restitution, compromises, sureties, and lastly of the oath of calumny.* Book iii. treats of judicia and judices, and judicial proceedings generally; of holidays, of the various jurisdictions, of illegal (inofficiosa) testaments and donations, of dowries and inheritances, of the Lex Aquilia, of mixed actions, of actions for crimes committed by slaves, of gaming, of burying-places and funeral expenses. Book iv. begins with the explanation of personal actions which are founded on loan and other causes; of obligations and actions, with their effect in relation to heirs and other persons bound by them; of testimony and written evidence; of things borrowed for use; of contract by pledge, and the personal action thereon; of compensation, interest, deposit, mandate, partnership, buying and selling, permutation, hiring, and emphyteutic contracts. Book v. treats of betrothment, gifts in contemplation of marriage, of marriages, women's portions, and the action that lies for the recovery of the dowry, of gifts between husband and wife, of estates given in dowry, of alimony, of concubines, natural children, and the process of legitimation. It next treats of tutorships (tutela), of the administration by tutors, and of the alienation of minors' estates. Book vi. treats of slaves, and freedmen, and the rights of their patrons; then it explains at large the Prætorian possession called "Bonorum possessio:" after which it expounds the whole matter of testaments, as institutions and substitutions of heirs, preteritions and disinheritings, refusals of inheritance, the opening of wills, codicils, legacies, and fiduciary bequests, and lastly succession to the property of intestates. Book vii. treats of manumissions; afterwards of matters relating to prescription, of judgments (sententiæ) and appeals, of the cession of estate or goods, of the seizure of goods, of the privileges of the exchequer, those of dowries, and the revocation of alienations made to defraud creditors. Book viii. begins with interdicts: it then treats of pledges and pawns, of stipulations, novations, delegations, &c. It treats next of the paternal power, of the emancipation of children and their ingratitude; it then explains what is meant by custom, or unwritten law; it next speaks of gifts (donationes mortis causâ, &c.) and their various kinds; and lastly, of taking away the penalty of celibacy. Book ix. treats of crimes, criminal judgments and punishments. Book x. treats of the rights and prerogative of the exchequer, of vacant goods, of treasurers, taxes levied upon the people, and tolls; of the decuriones and their office, of the freedom of citizens, of domicilia, of public offices and exemption from them, and of the various kinds of public offices and functions appertaining to them. Book xi. treats of the rights common to the city of Rome and municipal towns, the right of having corporate bodies and communities, and the right of having public registers. Book xii. continues the same subject, explaining the right of cities as to having offices civil and military, and also as to having functionaries for the execution of judgments and the orders of magistrates.

In the year following the publication of the first edition of his Code, Justinian undertook a much greater and more important work; to extract the spirit of jurisprudence from the decisions and conjectures, the questions and disputations, of the Roman civilians. In the course of centuries, under the republic and the empire, many thousand volumes had accumulated, filled with the learned lucubrations of the jurisconsults, but which no fortune could purchase, and no capacity could digest. The jurisconsults ever since the time of Augustus had been divided into opposite schools, and thus conflicting opinions were often produced, which only served to puzzle those who had to decide what was law. To put order into this chaos, was the object of Justinian. In December, 530, he commissioned seventeen lawyers, with Tribonian at their head, with full authority to exercise their discretion as to the works of their predecessors, by making a choice of those whom they considered as the best authorities. They chose about forty out of Tribonian's library, most of them jurisconsults who had lived during that period of the empire which has been sometimes called the age of the Antonines, from Hadrian to the death of Alexander Severus. From the works of these writers, said to have amounted to two thousand treatises, the commission appointed by Justinian was to extract and compress all that was suited to form a methodical, complete, and never failing book of reference for the student of law and the magistrate. Justinian gave Tribonian and his associates ten years' time to perform their task; but they completed it in three years. The work was styled 'Digesta,' and also 'Pandectæ' ("embracing all") and was published in December, 533. It was declared by the emperor that it should have the force of law all over the empire, and should supersede all the text books of the old jurists, which in future were to be of no authority.

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* Many of the terms here used are terms of Roman law, and as such do not admit of translation by equivalent English terms.

The following is a list of the Roman jurists from whose works the 'Pandect' or 'Digest' was composed, with their several epochs, so far as they can be ascertained, and the relative proportions which they have contributed to the 'Pandect.' Where (*a*) is added, the contribution is less than 1. The sum total of all the figures denotes the whole amount, of which the several figures opposite each jurist's name denote the proportion which his part bears to the whole. In addition to the extracts contained in the 'Pandect' from each author, many of them are very often merely cited.

Aburnus (Valens).	
Ælius (Gallus, Marcianus).	
Æmilius (Macer, Papinianus).	
Africanus, lived in Hadrian's time and was a disciple of Salvius Julianus	24
Alfenus, a native of Cremona, and a pupil of Servius Sulpicius, who died B.C. 43.	9
Anthianus, time unknown	(*a*)
Anthus (Anthianus).	
Antistius (Labeo).	
Aquila, supposed by some to have lived under Sept. Severus	(*a*)
Arcadius, under Constantine the Great	2½
Arrius (Menander).	
Aurelius (Arcadius).	
Cæcilius (Africanus).	
Caius (Gaius).	
Callistratus, under Caracalla	17½
Celsus, lived under Trajan and Hadrian	23
Ceridius (Scævola).	
Charisius (Arcadius).	
Claudius (Hermogenianus, Saturninus, Tryphoninus).	
Clemens (Terentius).	
Domitius (Ulpianus).	
Florens (Tertullianus).	
Florentinus, time uncertain, supposed to have lived under Alex. Severus	4
Furius (Anthianus).	
Gaius, lived under Antoninus and Aurelius	72
Gallus, Aquilius, a friend of Cicero, with whom he was prætor, B.C. 66	(*a*)
Herennius (Modestinus).	
Hermogenianus, under Constantine	9½
Javolenus, lived under Trajan	23½
Julianus, lived under Hadrian, was a pupil of Javolenus, and author of the perpetual edict	90
Julius (Aquila, Paulus).	
Junius (Marcianus).	
Justus (Papirius).	
Juventius (Celsus).	
Labeo, lived under Augustus, was the head of the school called Proculeians from his disciple Proculus	12
Licinius (Rufinus).	
Lucius (Mæcianus, Papinianus).	
Macer, under Alexander Severus	10
Mæcianus, lived under Antoninus Pius	8
Marcellus, under Antoninus and Aurelius	32½
Marcianus, probably under Caracalla	38
Marcus (Labeo).	
Massurius (Sabinus).	
Mauricianus, lived under Antoninus	1½
Maximus, time unknown	(*a*)
Menander, under Severus and Caracalla	3
Modestinus, flourished under Alex. Severus and the Maximini	41½
Mucius, Quintus, son of P. Mucius Scævola, consul in the year 659 of Rome, or B.C. 95	1
Neratius, lived under Trajan	10
Papinianus, under Sept. Severus, whose friend he was; was put to death by Caracalla	104
Papirius, under Marcus Aurelius	2¼
Paternus (Tarruntenus).	
Paulus, flourished under Alexander Severus	297
Pomponius, lived under Antoninus Pius; another Pomponius is said to have lived under Alex. Severus	80
Priscus (Javolenus, Neratius).	
Proculus, lived under Nero and Vespasian	6
Publius (Alfenus, Anthianus, Juventius).	
Quintus (Mucius, Tertullianus, Venuleius).	
Rufinus, about the time of Alex. Severus	1½
Rutilius (Maximus).	
Sabinus, Massurius, flourished under Tiberius, was the head of the Sabinian school	1½
Salvius (Julianus).	
Saturninus, supposed by some to be the same as Venuleius	1
Saturninus Quintus (Venuleius).	
Scævola, Cervidius, under Antoninus and Aurelius	78½
Scævola, Mucius (Mucius).	
Sempronius (Proculus).	
Septimius (Tertullianus).	
Sextus (Pomponius).	
Tarruntenus, under Marcus and Commodus.	(*a*)
Terentius, lived under Hadrian and Antoninus	3½
Tertullianus, time uncertain, by some supposed to be the same as the father of the church	1¼
Titus (Gaius).	
Tryphoninus, under Severus and Caracalla	22
Valens, lived under Hadrian and Antoninus Pius	3
Varus (Alfenus).	
Venuleius, under Antoninus and Aurelius	10
Ulpianus, flourished under Alex. Severus, whose counsellor he was	610
Ulpius (Marcellus).	
Volusius (Mæcianus).	

If the whole 'Digest' is divided into three equal parts, the contributions of Ulpian are somewhat more than one-third.

The 'Digesta' is divided into 50 books, each book being also divided into titles, and subdivided into laws and paragraphs. The following are some of the principal heads. Book i. lays down the general principles and the different kinds of law; it then establishes the division of persons and of things; then speaks of senators, and of magistrates and their delegates and assessors: ii. treats of the jurisdiction of magistrates; of the manner of bringing actions, of compromises after an action is commenced: iii. explains what kind of persons are allowed to sue in law, and it defines who are styled infamous, and as such not permitted to sue; it then treats of advocates, proctors, syndics, and other counsellors: iv. treats of restitution, compromises, and arbitrations, after which it speaks of innkeepers and others in whose custody we leave anything: v. treats of trials; and complaints against inofficious (inofficiosa) testaments: vi. treats of real actions and their various kinds to recover one's property: vii. treats of personal services (servitutes, as usus fructus): viii. speaks of real services both in town and country: ix. treats of personal actions which are in imitation of real actions, as actions for a fault or crime committed by a slave, the action of the lex Aquilia, and the action against those who throw any thing into the highway by which any one is wounded or injured: x. treats of mixed actions, the action of partition of an inheritance, &c.: xi. speaks of interrogatories, and of such matters as are to be heard before the same judge (judex). It also treats of run-away slaves, of dice-playing, bribery, corruption, and false reports; and lastly, of burials and funeral expenses: xii. explains the action for a loan, condictions, &c.: xiii. continues the subject of the preceding, and treats of the action of pawning: xiv. and xv. treat of actions arising from contracts made by other persons and yet binding upon us; of the Senatus Consultum Macedonianum; and of the peculium: xvi. treats of the Senatus Consultum Velleianum, and of compensation, and the action of deposits: xvii. treats of the mandate, and of partnership (societas): xviii. explains the meaning and forms of the contract of sale, the annulling of this kind of contract; and treats of gain or loss upon the thing sold: xix. treats of bargains, of actions of hiring, of the action called æstimatoria, of permutation, of the action called præscriptis verbis, &c.: xx. treats of pledges and hypothecæ, of the preference of creditors, of the distraction or sale of things engaged or pawned: xxi. contains an explanation of the Ædile's edict concerning the sale of slaves and beasts, and also treats of evictions, warranties, &c.: xxii. treats of interest (usuræ), fruits, accessions to things, and of proofs and presumptions, and of ignorance of law and fact: xxiii. is upon betrothment (sponsalia), marriage, dowry, and agreements upon this subject, and lands given in dowry: xxiv. treats of gifts between husband and wife, divorces, and recovery of the marriage portion: xxv. treats of expenses laid out upon the dowry, of actions for the recovery of things carried away by the wife or other persons against whom there is no action for theft, of the obligation to acknowledge children and provide for them, on the Rescript De Inspiciendo Ventre, and lastly of concubines: xxvi. and xxvii. treat of tutorship and curatorship, and the actions resulting from them: xxviii. treats of testaments, of the institution and disinheriting of children, of the institution of an heir, of substitutions, &c.: xxix. treats of military testaments, of the opening of wills, and of codicils: xxx., xxxi., xxxii. treat of legacies and fiduciary bequests in general: xxxiii. and xxxiv. treat of particular legacies, of the ademption of legacies, and of the Regula Catoniana: xxxv. treats of legacies on condition, and of the Lex Falcidia: xxxvi. treats of the Senatus Consultum Trebellianum, and of fiduciary bequests, of the time when they become due, of the security to be given by the heir, &c.: xxxvii. treats of universal succession by bonorum possessio: xxxviii. treats of the services due by freedmen to their patrons, of the succession of freedmen, of the succession of intestates appointed by the prætor, of heredes Sui and Legitimi, and of the Senatus Consultum Tertullianum and Orphitianum: xxxix. explains the means which the law or the prætor provides for preventing any one from receiving damage where a personal, real, or mixed action will not lie, after which it ends with the explanation of donations generally, and of such as are made in contemplation or view of death (mortis causâ): xl. relates to manumission or freeing of slaves: xli. treats of the various ways by which the property of things is acquired, and of the acquisition and loss of possession, and lastly of lawful causes which authorise possession and lead to usucaption: xlii. treats of definitive and interlocutory sentences, of confessions in judgment, of the cession of goods, of the causes of seizure and their effects, of the privileges of creditors: of curators appointed for the administration of goods, and of the revocation of acts done to defraud creditors: xliii. treats of interdicts and possessory actions: xliv. speaks of pleas (exceptiones) and defences, and of obligations and actions: xlv. of stipulations, &c.: xlvi. of sureties, novations, delegations, payments, discharges, prætorian stipulations, &c.: xlvii. treats of private offences: xlviii. treats of public offences; then follow accusations, inscriptions, prisons; and lastly it treats of torture, punishments, confiscation, relegation, deportation, and of the bodies of malefactors executed: xlix. treats of appeals; and then gives an account of the rights of the exchequer, and of matters relating to captives, military discipline, soldiers and veterans: l. treats of the rights of cities and citizens, of decuriones and their children, of public offices, of immunities, of deputies and ambassadors; of the administration of things belonging to cities, of public works, fairs, &c.; of taxes laid upon the provinces, concluding with the interpretation and signification of legal terms, and with the rules of law.

Of the merits and imperfections of the 'Digest,' Cujas, Hotomannus, Heineccius, Gravina, Schulting, Bynkershoek, and many others have amply spoken. With all its faults it is a noble work, and much superior to the Code in its style, matter, and arrangement; it has, in great measure, embodied the wisdom of the most learned men of the best age of the empire, men who grounded their opinions on the principles of reason and equity, and who for the most part were personally unconcerned and disinterested in the subjects on which they gave their responsa. Tribonian and his colleagues are charged with making many interpolations, with altering many passages in the writings of their predecessors, substituting their own opinions, and passing them off to the world under the name of the ancient jurists. Justinian himself acknowledged that he was obliged to accommodate the old jurisprudence to the altered state of the times, and to "make the laws his own." Another charge, which is, however, unsupported by evidence or probability, is, that Justinian and his civilians purposely destroyed the old text books that had served them for the compilation of the 'Pandects.' Long, however, before Justinian's time, the works of the ancient jurists were partly lost, and the vicissitudes of the ages that followed may easily have obliterated the rest. While the Digest was being compiled, Justinian commissioned Tribonian and two other civilians, Theophilus and Dorotheus, to make an abridgement of the first principles of the law, for the use of young students who should wish to apply themselves to that science. This new work, being completed, was published under the name of 'Institutiones,' about one month before the appearance of the Digest. The Institutions were mainly based on an older work of the same description and title. [GAIUS, in BIOG. DIV.] They are arranged in four books, subdivided into titles. As the law has three objects, persons, things, and actions, the first book treats of persons or status; the second and third, and first five titles of the fourth, treat of things; and the remaining titles of the fourth book treat of actions. [ROMAN LAW.]

Besides these three compilations, the Code, the Institutes, and the Digest, Justinian, after the publication of the second edition of his Code, continued to issue new laws or constitutions chiefly in Greek upon particular occasions, which were collected and published together after his death under the name of *Νεαραί Διατάξεις*, or Novæ or Constitutiones Novellæ, or Authenticæ. The Novellæ are divided into nine Collationes and 168 Constitutiones, or, as they are now often called, novels. The Novellæ, together with thirteen Edicts of Justinian, make up the fourth part of his legislation. There are four Latin translations of the Novellæ, two of which were made soon after Justinian's death; the third is by Haloander, printed at Nürnberg in 1531; and the fourth was printed at Basel by Hervagius in 1561. This first translation is that which is printed in the editions of the Corpus Juris opposite to the Greek text, and is very valuable, notwithstanding it has been stigmatised by some with the name "barbarous:" it is sometimes called Authentica Interpretatio or Vulgata; a recent and valuable edition is that of G. E. Heimbach, 2 vols. 8vo, Lips. 1846–50. The version of Haloander is also printed in some editions of the Corpus Juris. The Novellæ made many changes in the law as established by Justinian's prior compilations, and are an evidence that the emperor was seized with a passion for legislating; a circumstance which enables us to form a more correct judgment of his real merits, and lowers his character as a philosophic jurist.

(Ludewig, *Vita Justiniani Magni atque Theodoræ, nec non Triboniani*, Halle, 1731; Zimmern, *Geschichte des Römischen Privatrechts bis Justinian*, Heidelberg, 1826; Hugo, *Lehrbuch der Geschichte des Römischen Rechts*, Berlin, 1832; *History of the Roman or Civil Law*, by Ferriere, translated by J. Beaver, London, 1724; Hommelii, *Palingenesia*; Brinkmannus, *Institutiones Juris Romani*, Schleswig, 1822; *System des Pandekten-Rechts*, by Thibaut, 7th ed., Jena, 1828; *Das Corpus Juris in's Deutsche übersetzt von einem vereine Rechtsgelehrter und herausgegeben von* Otto, Schilling und Sintenis, Leipzig, 1831; Irving's *Introduction to the Civil Law*; *Les Cinquante Livres du Digeste, &c., Traduits en Français par feu* M. Henri Hulot, Paris, 1805; *Pandectes de Justinien mises dans un nouvel ordre, &c., par R. J. Pothier, traduites par Bréard Neuville, révues et corrigées par* M. Moreau de Montalin, Avocat, Paris, 1810; Pothier's edition of the *Digest*, reprinted at Paris, in 5 vols. 4to, 1818–20, is a useful edition; there is a very cheap edition of the *Corpus Juris*, published in Germany, by Beck, 3 vols., small fol., Leipzig, 1829; the editions of the Corpus Juris and of the Institutes are very numerous.) [CORPUS JURIS; GAIUS, in BIOG. DIV.]

JUVENILE OFFENDERS. Numerous statutes have been passed of late years with the view of providing for the effectual reformation of criminal children; but the law is still in a transitional if not experimental state. Criminal Courts are now however enabled to sentence juvenile criminals to confinement in reformatories, which the magistrates of counties and districts are enabled to provide for this purpose, the parents being compellable, if able, to provide for their maintenance and education. The progress of public opinion and of legislation on this subject of deep interest and of national importance will be found traced in a work recently published by Mr. M. D. Hill, the Recorder of Birmingham, which is devoted to an account of the means to be taken for the repression of crime.

JYAR, in Hebrew אִיָּר, is the eighth month of the Jewish year. It coincides, when earliest, with our April; but when the year is lengthened by the addition of a thirteenth month, it may be as late as our May. In the present year (1860) it begins on the 23rd of April. We usually pronounce the word *Jyar*, but it should be sounded *Ecar*, curiously like the Greek *Ἔαρ*, "the spring," with which some etymologists believe the word to be connected. Josephus, in the eighth book of his 'Antiquities,' c. 3, § 3, writes it *Ἰὰρ*. In the two manuscripts containing the old calendar of Heliopolis (Balbek) we find it *Ιαραρ* and *Αραρ*.

The Jewish almanacs mention several fasts in this month, but they do not appear to be all generally observed: one of three days' duration is set down for the commencement of Jyar, to be observed as an expiation by any persons who may have committed excesses during the celebration of the Passover in the preceding month; another, on the 10th, is held in memory of the death of Eli, and of the seizure of the Ark by the Philistines (1 Samuel iv. 18); another is kept for the death of Samuel on the 27th. The festivals in this month are only partially celebrated: one, on the 7th, in commemoration of a second consecration of the Temple by the Maccabees; one, on the 23rd, for the capture of Gaza (1 Macc. xiii. 43), or else for the capture of the tower of Jerusalem (ibid, v. 51); and a third is attributed, on insufficient authority, to the 27th, in memory of the expulsion of the Galilæans (?) by the Maccabees, but this would clash with the fast-day above mentioned, instituted to commemorate the death of the prophet Samuel. It appears from the 6th chapter of the 1st book of Kings, v. 1, that the ancient name of this month was Zif; it is called there "the second month," that being its place in the calendar before the commencement of the year was transferred from the spring to the autumn, or from Nisan to Tisri. [BUL.] The name occurs again in the 37th verse. Jyar has 29 days only.

K

K has the same sound which C has before the vowels *a*, *o*, *u*. A reference to that consonant will therefore suffice for the power of the letter; its various forms may be seen in ALPHABET. Although this letter is now superfluous, it was not so when the characters of an alphabet were syllabic in power. Thus the letter *k* appears to have denoted at one time the syllable *ka*, while another character represented *ko*, and so on. Hence in the Greek and Hebrew alphabets the former was called *kappa*, *kaph*: the latter *koppa*, *koph*. This accounts for the fact, that in Latin the letter *k* was never used except before the vowel *a*, precisely as *q* is found only before *u*, and the Greek koppa only before *o*. Even our own alphabet seems to imply such a limit in the use of this consonant, when it gives it the name *ka*, not *ke*; though the latter name would better agree with *be*, *ce*, *de*, &c.

KAKODYL. Synonymous with CACODYL.

KAKOPLATYL. [CACOPLATYL.]

KAEMPFERIDE. A yellow inodorous crystalline substance contained in the root of the *Galanga* (*Kaempferia Galanga*). It fuses below 212° Fahr. and dissolves in 25 parts of ether at 60°. It consists of—

Carbon	65·3
Hydrogen	4·3
Oxygen	30·4
	100·0

KALEIDOPHONE. [ACOUSTICS.]

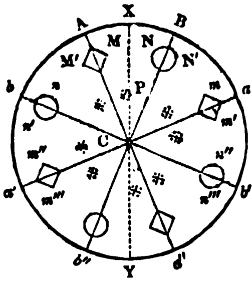
KALEIDOSCOPE, a name compounded of two Greek words (καλὸς and σκόπος), and denoting the exhibition of beautiful forms, is the designation of an optical instrument which was invented by Dr. (now Sir David) Brewster, and patented by him in 1817.

About three years before that time Sir David Brewster, being engaged in making experiments on the polarisation of light by reflection, from plates of glass, observed that when two plates were inclined to one another, and the eye of the spectator was nearly in the produced line of the common section of their planes, the farther extremities of the plates were multiplied by successive reflections so as to exhibit the appearance of a circle divided into sectors, also that the several images of a candle near those extremities were circularly disposed about the centre; and these circumstances suggested to him the construction of an instrument of the kind above named.

It may be observed, however, that the multiplication of the image of an object by successive reflections from mirrors inclined to one another had long before been a subject of investigation in treatises on optics; and both Baptista Porta and Kircher had given descriptions of instruments consisting of mirrors united at two of their edges, which, being opened like two leaves of a book, were capable of multiplying the images of objects. Bradley also, about the year 1717, constructed an instrument consisting of two plates of glass inclined to one another, which being placed on a drawing, with the line of section perpendicular to the paper, exhibited to the eye several images of the figures, disposed by successive reflections about a centre. But the optical investigations alluded to are very remotely connected with the properties of the kaleidoscope; and the application of the latter to objects which may be moveable and situated at any distances from the observer, render Brewster's instrument very different from and far superior to the simple contrivances of Porta, Kircher, and Bradley.

The essential parts of the instrument consist of two plane mirrors of glass, having their posterior surfaces blackened in order to prevent any reflection of light from thence; mirrors of polished metal would, however, be preferable: each mirror is from six to ten inches long, and of a trapezoidal form; the larger end about an inch and a-half long, and the shorter end about three-quarters of an inch; and the two are placed in contact with one another at a long end of each, so as to form a dihedral angle, the like ends being placed together: the object to be viewed is disposed contiguously to the larger ends, and the eye should be near the opposite extremity, but a little above the line of contact. The effects produced by the reflections of the light may be understood from the following considerations:—

Let A C, B C, in the first of the figures, be the two extremities of the mirrors on the side farthest from the eye of the observer, which is supposed to be near the opposite extremity of the line of section passing through C perpendicularly to the plane of the paper. These lines A C, B C, and the sectoral space between them (which in the figure is one-eighth part of a circle), will be visible by rays coming directly to the eye; and, at the same time, rays from the line A C falling on the mirror B C at a certain angle of incidence will, on being reflected from thence to the eye, give rise to the image C *a* of that line; in like manner rays from the line B C falling on the mirror A C at an equal angle of incidence will, after reflection, give rise to the image C *b* of the line. These, with the intermediate rays, produce the first reflected sectors B C *a* and A C *b*. Other rays from the sector A C *b* at the surface of the mirror A C will fall on the mirror B C; and, while a portion of them arrive at such angles of incidence as to be reflected to the eye and produce the perception of the sector *a* C *b′*, another portion of them will be reflected back to the mirror A C at such angles of incidence as to be re-reflected to the eye and cause the perception of the sector *a′* C *b″*. In a similar manner the rays first reflected from B C *a* will, by subsequent reflections, give rise to the perceptions of the sectors *b* C *a′*, *b′* C *a″*.



Thus it is easy to perceive that an object, as M, on A C, with its immediately reflected image M′, will give rise to the appearances of similar figures at *m m′*, *m″ m‴*; and an object, as N, on A B, with its immediately reflected image N′, will give rise to the appearances of similar figures at *n n′*, *n″ n‴*: also an object, as P, between A C and B C, will appear by reflection similarly situated in all the other sectors.

If the angle A C B be $\frac{1}{m}$th of four right angles, in which *m* is any term in the series of even numbers 4, 6, 8, 10, &c., the number of sectors will be *m*, and each of them will be equal to A C B, while C Y, the appearance of the line in which the mirrors meet each other, will, as in the figure, bisect the angle which is opposite to A C B; also if *m* be any term in the series of odd numbers 5, 7, 9, &c., the number of sectors will be *m*, and each of them will be equal to A C B, while C Y will coincide with the line in which the two lowest sectors join one another. It may hence be easily understood that if a flat object placed in the sector A C B, with its plane perpendicular to the mirrors, have its bounding-lines similarly situated with respect to A C and B C, the reflected images will be similar and equal to the original object; and the whole will constitute one symmetrical pattern, whether the value of *m* be odd or even: but if the bounding-lines are not similarly situated with respect to A C and B C, the reflected images will not, in the two lowest sectors, unite so as to correspond to the images in the other sectors, unless *m* be an even number. The second figure represents a pattern produced by the objects represented in the sector corresponding to A C B in the first figure.

In order that the whole pattern in the field of view might possess perfect symmetry about the centre C, it would be necessary that the eye should be exactly in the direction of the line in which the glass plates meet one another; but in such a situation the reflected images would not be visible: if the eye were far above the line of meeting, the visible field of view would be sensibly elliptical, and the brightness of the field would be diminished; it follows, therefore, that the eye should be near the smaller ends of the mirrors, and very little above the line of their junction. Again, it may be readily understood that, in order to permit the reflected images of objects to be symmetrically disposed about the centre of the field of view, the object should be exactly in a plane contiguous to the mirrors at the extremities which are farthest from the eye; for the line in which the planes of glass meet each other appearing to pass through the common centre of the visible sectors, if the object were placed on that line of junction, and either between the eye and those extremities or beyond the latter, it is evident, the eye being above the line of meeting, that the apparent or projected place of the object would not coincide with that common centre, but in the former case would appear below, and in the latter above, that centre. The length of the mirrors should be such that the object in the sector A C B may be distinctly visible; the eye may, however, if necessary, be assisted by a concave or a convex lens.

The first kaleidoscopes constructed by Sir David Brewster consisted simply of the two mirrors, which were fixed in a cylindrical tube; the objects were pieces of variously coloured glass attached to the farther ends of the mirrors and projecting on the sectoral space A C B between them; or the objects were placed between two plates of very thin glass, and held by the hand or fixed in a cell at the end of the tube. In some cases these plates were moved across the field of view, and in others they were made to turn round upon the axis of the tube. The pieces of coloured glass or other objects which were situated in the sector A O B were, by the different reflections, made to appear in all the other sectors; and thus the field of view presented the appearance of an entire object or pattern, all the parts of which were disposed with the most perfect symmetry. By moving the glass plates between which the objects were contained, the pattern was made to vary in form; and pleasing variations in the tints were produced by moving the instrument so that the light of the sky or of a lamp might fall on the objects in different directions. When the objects in the sector A O B are confined near its upper part, the images evidently form an annular pattern; and, on placing the two mirrors parallel to one another, the successive reflections of the objects produce one which is rectilinear.

Sir David Brewster subsequently found means to obtain multiplied images of such objects as flowers, trees, and even persons or things in motion. For this purpose he caused the two mirrors to be fixed in a tube as before, but this tube was contained in another from which, like the eye-tube of a telescope, it could be drawn at pleasure towards the eye: at the opposite end of the exterior tube was fixed a glass lens of convenient focal length, by which there were formed images of distant objects at the place of the sector A O B. These images thus became objects which being multiplied by successive reflections from the mirrors, produced in the field of view symmetrical patterns of great beauty.

Some kaleidoscopes have been executed in such a manner that the two mirrors may be placed at any required angle with one another, by which means the images in the visible field of view may be varied at pleasure. The instrument is capable also of being constructed so that the multiplied image may be projected on a screen, and thus made visible at one time to many spectators. In order to obtain this end, the rays of light from a powerful lamp are, by means of a lens, made to fall upon the object in A O B at the farther extremities of the two mirrors; and at the eye-end of the instrument is placed a lens of such focal length that the rays in each of the emergent pencils may converge at the screen: there will thus be formed on the latter a magnified image of the whole pattern. The tube containing the glass plates is frequently mounted on a stand having a ball-and-socket joint, on which it may be turned in any convenient direction; and the instrument being thus supported, the figures in its field may be easily sketched by a skilful artist, who by means of such an apparatus may be assisted in designing beautiful patterns.

Sir David Brewster's account of his invention is contained in his 'Treatise on the Kaleidoscope,' Edinburgh, 1819, of which a new edition has just been published (1860). Dr. Roget has shown ('Annals of Philosophy,' vol. xi.) that the properties of the instrument may be greatly extended by employing, not only two, but three, and even four plane mirrors, united together at their edges so as to form a hollow prism, or a frustum of a pyramid, the reflecting surfaces being towards the interior. Of these, which are called *Polycentral* kaleidoscopes, the instruments constructed with three plane mirrors appear to produce the most pleasing effects; the mirrors may be disposed so that a section perpendicular to the axis shall be an equilateral triangle, a right-angled isosceles triangle, or a right-angled triangle having its two acute angles equal to 30° and 60°. The first disposition of the mirrors affords regular combinations of images in three different directions which cross each other at angles of 60° and 120°; and to instruments of this kind Dr. Roget gave the name of *Triascope*. With the second disposition the field is divided into square compartments having the hypothenuse of the triangle for their sides: this is called a *Tetrascope*. The third disposition exhibits a field of view divided into hexagonal compartments; and hence the instrument is designated a *Hexascope*.

KALENDÆ. [KALENDAR.]

KALENDAR, a register or distribution of the year, accommodated to the uses of life, containing the order of days, weeks, months, festivals, &c., as they occur in the course of the year. It is so called from the *Kalendæ*, or Kalends, which among the Romans denoted the first day of every month. The kalendar, being of civil institution, varies according to the different distributions of time in different countries. Those which we shall take more particular notice of are, the Roman, the Julian, the Gregorian, and the Reformed kalendar: a slight mention of the others will be sufficient.

Romulus, according to tradition, formed what is deemed the original Roman kalendar, by which the year was divided into ten months only, consisting of an unequal number of days, and began with March. The total number of days was 304. It was however soon discovered that the civil year, as thus constituted, was much shorter than the solar year. Romulus therefore added two intercalary months to every year; but these months were not inserted in the kalendar, nor were any names assigned to them until the following reign. Some Roman antiquarians maintained that the old kalendar continued in use till the time of Tarquinius Priscus.

Numa, in imitation of the Greeks, divided the year into twelve months, according to the course of the moon, consisting in all of 354 days: according to Pliny ('Hist. Nat.,' xxxiv. 7), he afterwards added one day more to make the number odd, which was thought a more fortunate number. But as 10 days, 5 hours, 49 minutes (or rather 48 minutes 58 seconds) were wanting to make the lunar year correspond to the course of the sun, he intercalated every other year an extraordinary month, called *Mensis intercalaris*, or *Mercedonicus*, between the 23rd and 24th of February. This month appears to have consisted alternately of 22 and 23 days during periods of 22 years, the last biennium in the 22 years being entirely passed over. The intercalation of this month was left to the discretion of the pontifices, who, by inserting more or fewer days, used to make the current year longer or shorter, as was most convenient for themselves or their friends; for instance, that a magistrate might sooner or later resign his office, or contractors for the revenue have longer or shorter time to collect the taxes. In consequence of this licence the months were transposed from their proper seasons; the winter months carried back into autumn, and the autumnal into summer. Some critics are of opinion that there is a reference to this confusion in one of Cicero's letters to his friend Atticus (x. 17).

Julius Cæsar, when he had made himself master of the state, resolved to put an end to this disorder, by abolishing the use of the intercalations; and for that purpose (B.C. 47) adjusted the year according to the course of the sun, and assigned to the months the number of days which they still contain. He also added an intercalary day to February every four years. [BISSEXTILE.] To make everything proceed regularly, from the 1st of the ensuing January, he inserted in the current year, besides the intercalary month of 23 days, which fell into it, two extraordinary months between November and December, the one of 33, the other of 34 days; so that this year, which was called the last year of *confusion*, consisted of 15 months, or 445 days. (Sueton., Vit. J. Cæs., c. 40.) These 67 days were inserted in order to set the year right, which was 67 days in advance of the true time.

All this was effected by the care and skill of Sosigenes, an astronomer of Alexandria, whom Cæsar had brought to Rome for that purpose; and a new kalendar was formed from his arrangement by Flavius, digested according to the order of the Roman festivals, and the old manner of computing the days by kalends, nones, and ides, which was published and authorised by the dictator's edict.

This is the *Julian* or Solar year, which continues in use to this day in all Christian countries, without any other variation than that of the *old* and *new style*, which was occasioned by a regulation of Pope Gregory XIII., A.D. 1582, who, observing that the vernal equinox, which at the time of the council of Nice, A.D. 325, had been on the 21st of March, then happened on the 10th, by the advice of astronomers caused ten days to be thrown out of the current year, between the 4th and 15th of October; and to make the civil year for the future to agree with the real one, or with the annual revolution of the earth round the sun, or, as it was then expressed, with the annual motion of the sun in the ecliptic, which is completed in 365 days, 5 hours, 49 minutes, he ordained that every 100th year should not be leap-year, excepting the 400th; so that the difference will hardly amount to a day in 7000 years, or, according to a more accurate computation of the length of the year, to a day in 5200 years.

This alteration of the style was immediately adopted in all Catholic countries; but not in Great Britain till the year 1752, when eleven days were dropped between the 2nd and 14th of September, so that this month contained only nineteen days; and thenceforth the new or reformed style was adopted, as it had been before in most other countries of Europe. The same year also another alteration was made in England, by which the legal year, which before had begun on the 25th of March, began upon the first of January; this alteration first took place on the 1st of January, 1752: see the Statute 24 Geo. II., ch. 23. By this statute it was also enacted that the several years of our Lord 1800, 1900, 2100, 2200, 2300, or any hundreth year of our Lord which shall happen in time to come, except only every fourth hundreth year of our Lord, whereof the year 2000 shall be the first, shall not be deemed bissextile or leap-years, but shall be considered as common years, consisting of 365 days only; and that the years of our Lord 2000, 2400, 2800, and every other fourth hundredth year of our Lord from the year 2000 inclusive, and also all other years of our Lord which, by the present computation, are considered bissextile or leap-years, shall, for the future be esteemed bissextile or leap-years, consisting of 366 days: and that whereas according to the rule then in use for calculating Easter-day, that feast was fixed to the first Sunday after the first full moon next after the 21st of March; and if the full moon happens on a Sunday, then Easter-day is the Sunday after; which rule had been adopted by the general council of Nice; but that as the method of computing the full moons then used in the church of England, and according to which the table to find Easter prefixed to the book of Common Prayer is found, had become erroneous, it was enacted that the said method should be discontinued, and that from and after the 2nd of September, 1752, Easter-day and the other moveable and other feasts were henceforward to be reckoned according to the kalendar tables and rules annexed to the Act, and attached to the books of Common Prayer. This was, in fact, an enactment of the Gregorian alteration, though no allusion to the source of the alteration is made. [EASTER, METHOD OF FINDING.]

It is not generally known that an effort was made to reform the kalendar in England as early as the reign of Queen Elizabeth. On the 16th of March, 27 Eliz., A.D. 1584-5, a bill was read the first time in the House of Lords, entitled "An Act giving Her Majesty authority to alter and new make a Kalendar according to the Kalendar used in other Countries." It was read a second time on the eighteenth of that month, after which no notice occurs of the proposed measure.

The formation of the *Hebrew* kalender is fixed by some to the same year as the council of Nice, A.D. 325; others have placed it in the year 360: and others as late as A.D. 500. Lindo however assures us that the Mishna compiled according to the Jewish account in the year A.D. 141, proves that the kalendar as used by the Jews in its present form, with the intercalary month, was generally known and followed at that time.

For further information upon the Jewish kalendar the reader may consult Dr. Adam Clarke's 'Commentary upon the Bible,' and Lindo's 'Jewish Calendar.'

Two Kalendars are in use in the East: the Arabian, which is common to all the Mohammedan countries; and the Persian, the use of which is peculiar to that country. This last is founded on the Persian era called 'Yezdegird.'

Of the three parts into which the Romans divided their month, the *kalendæ*, or kalends, have been already explained. They were so called (à *calando* vel *vocando*), from the pontifex calling out to the people that it was new moon. The fifth day of the month was called *Nonæ*, the nones, and the 13th *Idus*, the ides, from the verb *iduare*, to divide; because the ides nearly divided the month. The nones, from *nonus*, the ninth, were so called because, counting inclusively, they were nine days from the ides. In March, May, July, and October, the nones fell on the 7th and the ides on the 15th of the month. The mode of fixing any particular day was by saying that it was so many days before the kalends, nones, or ides, next immediately following. Thus the 28th of April was the 4th day before the kalends of March; the 4th of March was the 4th day before the nones of March; and the 9th of March was the 7th day before the ides of March.

The Attic year consisted of twelve lunar months of 30 and 29 days alternately: an intercalary month of 29 or 30 days was inserted every two years, but as this was 7½ days too much, the intercalary month was sometimes omitted. The full Attic month consisted of 30 days, and was divided into three decades.

On the subject of the Greek Kalendar the reader may consult Ideler, 'Handbuch der Mathematischen und Technischen Chronologie.'

(Adams's *Roman Antiquities*; Niebuhr, *On the Secular Cycle, Hist. of Rome*; Brady's *Clavis Calendaria*; Sir Harris Nicolas's *Chronology of History*; Hutton's *Philosophical and Mathematical Dictionary*, v. *Calendar*; Lindo's *Jewish Calendar*, 8vo. Lond. 1838.)

The last we shall mention is the *French Revolutionary Kalendar*. In September, 1793, the French nation resolved that the republic should form a new era, and that a kalendar should be adopted on what were termed philosophical principles. The Convention therefore decreed, on the 24th of November, 1793, that the common era should be abolished in all civil affairs: that the new French era should commence from the foundation of the republic, namely, on the 22nd of September, 1792, on the day of the true autumnal equinox, when the sun entered Libra at 9ʰ 18ᵐ 30ˢ in the morning, according to the meridian of Paris; that each year should begin at the midnight of the day on which the true autumnal equinox falls; and that the first year of the French republic had begun on the midnight of the 22nd of September, and terminated on the midnight between the 21st and 22nd of September, 1793. To produce a correspondence between the seasons and the civil year, it was decreed, that the fourth year of the republic should be the first sextile, or leap-year; that a sixth complementary day should be added to it, and that it should terminate the first Franciade; that the sextile or leap-year, which they called an olympic year, should take place every four years, and should mark the close of each Franciade; that the first, second, and third centurial years, namely, 100, 200, and 300 of the republic, should be common, and that the fourth centurial year, namely, 400, should be sextile; and that this should be the case every fourth century until the 40th, which should terminate with a common year. The year was divided into twelve months of thirty days each, with five additional days at the end, which were celebrated as festivals, and which obtained the absurd name of "Sansculottides." Instead of the months being divided into weeks, they consisted of three parts, called Decades, of ten days each. It is however to be observed that the French republicans rarely adopted the decades in dating their letters, or in conversation, but used the number of the day of each month of their kalendar.

The republican kalendar was first used on the 26th of November, 1793, and was discontinued on the 31st of December, 1805, when the Gregorian was resumed.

On examination we find that many works give an account of this kalendar which is more or less incorrect. The decrees of the National Convention, which fixed the new mode of reckoning, were both vague and insufficient, so that it is no wonder that many detailed accounts neither agree with each other nor with the truth. To learn what the truth was, we have recourse to a French work, in its sixth edition: 'Concordance des Calendriers Républicain et Grégorien,' par L. Rondonneau, Paris (6ième édition), 1812, 8vo. This work puts every day of every year, from An II. to An XXII. both inclusive, opposite to its day of the Gregorian calendar; it also gives the decrees of the National Convention. The account we have already given is stated in the common way: we leave it for the reader to compare with the more accurate version.

By these decrees it appears that the year is to begin at the midnight of Paris Observatory which precedes the true autumnal equinox. It is to consist of 365 days, with 12 months of 30 days each (the 30 days being 3 decades of 10 days each), and 5 complementary days, which were tastefully called *sansculotides* (a name afterwards repealed). A sixth complementary day was to be added, not according to any rule, but *selon que la position de l'équinoxe le comporte*; and although it was stated that it would be *ordinairement nécessaire* to add this 366th day once in four years, yet it is not even stated in what particular coming years the necessity would arise. The first decree, dated October 5, 1793 (the new month not having been introduced), declares the year then current to be the second year of the French republic, and enacts that An I. began with September 22, 1792, and An II. with September 22, 1793. The second decree, fixing the months, is dated the 4th of Frimaire, An II. (November 24th, 1793). The Gregorian reckoning was restored from and after January 1, 1806, by an imperial ordonnance, dated 22 Fructidor, An XIII. (September 9, 1805).

It is to actual usage, then, that we must appeal to know what the decrees do not prescribe—namely, the position of the leap-years. For though every period of four years was a *Franciad*, and the last year of the Franciad was called *Sextile* (having six complementary days), yet, in fact, An IV., An VIII., &c., are not leap-years. The following list, actually made from the work above mentioned, must be used as a correction of the usual accounts. For various matters connected with the public debt, &c., it was necessary to construct the table up to An XXII.

			Sept.				Sept.
An	I.	begins	22, 1792	An	XII.	begins	24, 1803
	II.	„	22, 1793		XIII.	„	23, 1804
Sext.	III.	„	22, 1794		XIV.	„	23, 1805
	IV.	„	23, 1795	Sext.	XV.	„	23, 1806
	V.	„	22, 1796		XVI.	„	24, 1807
	VI.	„	22, 1797		XVII.	„	23, 1808
Sext.	VII.	„	22, 1798		XVIII.	„	23, 1809
	VIII.	„	23, 1799	Sext.	XIX.	„	23, 1810
	IX.	„	23, 1800		XX.	„	24, 1811
	X.	„	23, 1801		XXI.	„	23, 1812
Sext.	XI.	„	23, 1802		XXII.	„	23, 1813

When the Gregorian year is not leap-year the beginnings of the months are as follows, according as the republican year begins on September 22, 23, or 34:—

1	Vendémiaire	is	Sept.	22, 23, 24
1	Brumaire	is	Oct.	22, 23, 24
1	Frimaire	is	Nov.	21, 22, 23
1	Nivose	is	Dec.	21, 22, 23
1	Pluviose	is	Jan.	20, 21, 22
1	Ventose	is	Feb.	19, 20, 21
1	Germinal	is	March	21, 22, 23
1	Floréal	is	April	20, 21, 22
1	Prairial	is	May	20, 21, 22
1	Messidor	is	June	19, 20, 21
1	Thermidor	is	July	19, 20, 21
1	Fructidor	is	Aug.	18, 19, 20

1	Jan.	is	Niv.	12, 11, 10
1	Feb.	is	Pluv.	13, 12, 11
1	March	is	Vent.	11, 10, 9
1	April	is	Germ.	12, 11, 10
1	May	is	Flor.	12, 11, 10
1	June	is	Prair.	13, 12, 11
1	July	is	Messid.	13, 12, 11
1	Aug.	is	Thermid.	14, 13, 12
1	Sept.	is	Fructid.	15, 14, 13
1	Oct.	is	Vendém.	10, 9, 8
1	Nov.	is	Brum.	11, 10, 9
1	Dec.	is	Frim.	11, 10, 9

But when the Gregorian year is leap-year the beginnings of the months are as follows, according as the republican year begins on September 22, 23, or 24:—

1	Vendém.	is	Sept.	22, 23, 24
1	Brum.	is	Oct.	22, 23, 24
1	Frim.	is	Nov.	21, 22, 23
1	Niv.	is	Dec.	21, 22, 23
1	Pluv.	is	Jan.	20, 21, 22
1	Vent.	is	Feb.	19, 20, 21
1	Germ.	is	March	20, 21, 22
1	Flor.	is	April	19, 20, 21
1	Prair.	is	May	19, 20, 21
1	Messid.	is	June	18, 19, 20
1	Thermid.	is	July	18, 19, 20
1	Fructid.	is	Aug.	17, 18, 19

1	Jan.	is	Niv.	12, 11, 10
1	Feb.	is	Pluv.	13, 12, 11
1	March	is	Vent.	12, 11, 10
1	April	is	Germ.	13, 12, 11

1	May	is	Flor.	13, 12, 11
1	June	is	Prair.	14, 13, 12
1	July	is	Messid.	14, 13, 12
1	Aug.	is	Thermid.	15, 14, 13
1	Sept.	is	Fructid.	16, 15, 14
1	Oct.	is	Vendém.	11, 10, 9
1	Nov.	is	Brum.	12, 11, 10
1	Dec.	is	Frim.	12, 11, 10

For instance, what is 14 Floréal, An XII.? The republican year begins Sept. 24, 1803, so Floréal falls in 1804, which is Gregorian leap-year. Look at the third table, and when the year begins Sept. 24, the 1st of Floréal is April 21; consequently the 14th is May 4, 1804. Again, what is June 17, 1800, in the French calendar? The year is not Gregorian leap-year; and An VIII. contains it, which begins Sept. 23. Look in the second table, and in such a year it appears that June 1 is the 12th of Prairial; therefore June 17 is Prairial 28.

KALENDS. [Kalendar.]

KALIF. [Caliph.]

KALISACCHARIC ACID. Synonymous with Glucic Acid.

KAPNOMOR. [Capnomor.]

KEEPER, LORD. [Lord Keeper.]

KELP. [Iodine.]

KERMES MINERAL. [Antimony.]

KERSEY, KERSEYMERE. [Woollen Manufactures.]

KETONES. This name is applied in organic chemistry to a class of bodies obtained by submitting certain salts of the fatty acids, such as acetic acid, to dry distillation. *Acetone* is one of the best known ketones, and the mode of its formation will represent that of the rest of these bodies. It is best produced by distilling acetate of lime, when the following reaction occurs:

$$\underbrace{2(CaO, C_4H_3O_3)}_{\text{Acetate of lime.}} = \underbrace{2(CaO, CO_2)}_{\text{Carbonate of lime.}} + \underbrace{C_6H_6O_2}_{\text{Acetone.}}$$

Various views of the constitution of the ketones have been entertained by chemists, but the one now almost universally held regards them as compounds of a negative with a positive organic radical. Thus according to this view, acetone is written as methide of othyl:

$$\text{Acetone} = \left.\begin{matrix} C_4H_3O_2 \\ C_2H_3 \end{matrix}\right\}$$

In all the ketones hitherto known, the positive radical always contains two equivalents of carbon less than the negative, but it is not improbable that ketones may be formed in which this relation between the radicals will not obtain.

The ketones may thus be regarded as aldehydes, in which the single equivalent of hydrogen is replaced by a compound positive radical; thus—

$$\underbrace{\left.\begin{matrix} C_4H_3O_2 \\ H \end{matrix}\right\}}_{\text{Vinic aldehyde.}} \qquad \underbrace{\left.\begin{matrix} C_4H_3O_2 \\ C_2H_3 \end{matrix}\right\}}_{\text{Acetone.}}$$

The following are the principal ketones at present known:—

Acetone	$C_6H_6O_2$
Propione	$C_{10}H_{10}O_2$
Butyrone	$C_{14}H_{14}O_2$
Valerone	$C_{18}H_{18}O_2$

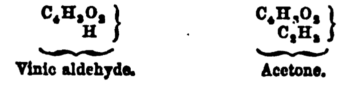
The ketones, as a class, have hitherto been very incompletely studied.

KEY, in music, is the particular diatonic scale, whether major or minor, in which a composition begins and ends, and which more or less prevails in a given piece of music.

The diatonic scale may commence on any note, and that chosen—called the *Key-Note*—governs the progression of the other notes. [Scale; Diatonic.] If a composition begins and ends in a scale in which neither sharps nor flats are used, it is in the key of C, the distinctive term *natural* being understood. When three flats are placed at the clef, and the last and lowest note in the piece is E♭, the key is E♭. If in such case the last and lowest note is C, the key is C minor, &c.

As any note in the diatonic and chromatic scales may be taken as a key-note, it follows that there are twelve keys in the major mode, and twelve in the minor; for each scale may have either a major or a minor 3rd. [Major; Minor.] Hence arise twenty-four keys. But as three major and consequently three minor keys are binominous, there are in name thirty different keys, and as many signatures are in actual use [Signature]; though, in fact, there is only the beforementioned number of keys differing in reality.

Table of Major Keys.



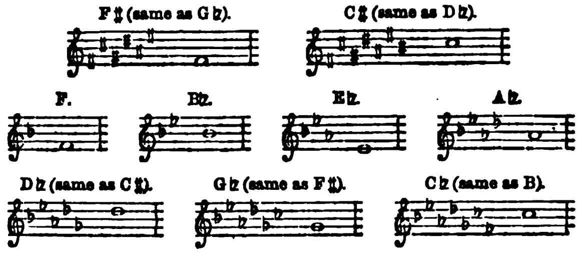
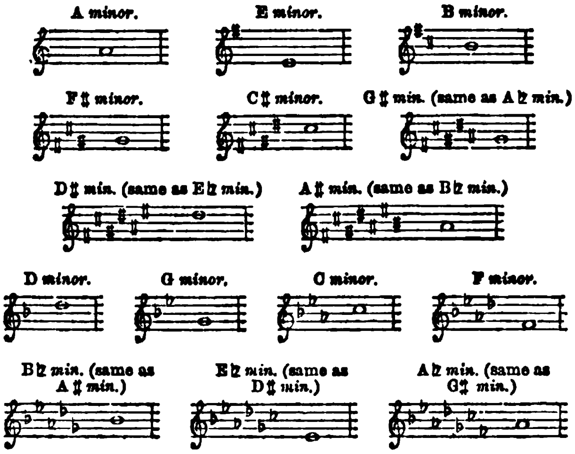


Table of Minor Keys.


A minor.
E minor.
B minor.
F♯ minor.
C♯ minor.
G♯ min. (same as A♭ min.)
D♯ min. (same as E♭ min.)
A♯ min. (same as B♭ min.)
D minor.
G minor.
C minor.
F minor.
B♭ min. (same as A♯ min.)
E♭ min. (same as D♯ min.)
A♭ min. (same as G♯ min.)

By admitting double sharps and flats, the number of keys may be much farther, but not usefully, extended.

KHAN, a word of Mongol or Turkish extraction, said to mean "great and powerful lord," was employed by the nations of Central Asia to express the full extent of royal power. This title was assumed by Gengis when he became supreme ruler of the Mongols and Tartars, and was adopted by all his successors. The earlier monarchs of the Ottoman empire were also distinguished by this title. The word is used in Persia in a much more restricted sense, and is applied to the governors of provinces, and to all officers of a certain rank.

The original form of this word was *Khaghan;* Gengis Khan is always called Jinggis Khaghan in the Mongol language.

KIDNAPPING is defined to be the stealing or conveying away of a man, woman, or child, and is an offence at common law, punishable by fine and imprisonment, and, formerly, by pillory. The highest form of this offence, the forcibly sending a man from his own country into some other, or to parts beyond the seas, though at common law only punishable as above mentioned, is an offence, as has been remarked, of such primary magnitude that it might well have been substituted upon the roll of capital crimes, in the place of many others, which until recently were there to be found (1 East's Pleas of the Crown, c. ix., s. iv.).

The Jewish law declared that "he that stealeth a man, and selleth him, or if he be found in his hand, he shall surely be put to death" (Exod. xxi., 16). And by the civil law, the offence of spiriting away and stealing men and children, was punished with death. Magna Charta, the petition of right, and the habeas corpus acts are pointed to the security from expatriation, as are also the numerous legislative provisions and treaties for the suppression of the slave trade.

The forcible impressment of seamen for the royal navy is an odious exception to the right of the subject, in this country, to his personal liberty, when not charged with any crime, and is limited by various statutes, and the wrongful carrying off and leaving behind seamen, for private purposes, is punishable by imprisonment (see 17 & 18 Vict., c. 104).

The general remedy for the unlawful detention of persons is by application to the courts of law for a writ of habeas corpus. The rights of parents and guardians and others to the custody of children, alleged to have been wrongfully taken away or detained for the purposes of education or otherwise are in this way frequently discussed and decided.

The 9 Geo. IV., c. 21, which is directed against child-stealing, enacts that if any person shall maliciously, by force or fraud, lead, or take away, or decoy or entice away, or detain, a child under the age of ten years, with intent to deprive its parents, or any other person having the lawful care of such child, of the possession of it, or with intent to steal any article upon or about the person of such child, to whomsoever such article may belong, or shall receive and harbour with any such intent as aforesaid any such child, knowing that it has been by force or fraud led, taken, decoyed, enticed away, or detained, every such offender, and their counsellors, procurers, aiders, and abettors, shall be guilty of felony, and shall be liable to be transported for seven years, or to be imprisoned, with or without hard labour, in the common gaol or house of correction, for any time not exceeding two years; and if a male, to be once, twice, or thrice publicly or privately whipped (if the court shall so think fit) in addition to such imprisonment.

The act does not extend to a person who shall have claimed to be the father of an illegitimate child, or to have any right to the possession of such a child, on account of his getting possession of such child, or taking it out of the possession of the child's mother, or other person who has the lawful charge of it. The Irish act (10 Geo. IV., c. 34) is in precisely similar terms. (Kerr's Blackstone and Russell on Crimes by Greaves.)

As to the conveying away of heiresses and young women, see ABDUCTION.

KIDNEYS, DISEASES OF. The principal disease to which the kidneys are liable is that which gives rise to the formation of calculi. [CALCULUS.] Sometimes the stone is retained in the pelvis of the kidney, where, by continued depositions, it may increase till it completely fills the pelvis and calyces; but more frequently it passes through the ureters into the bladder, producing in its passage violent spasmodic pain in the loins, sickness and nausea, hæmorrhage, &c. This affection is the most common cause of inflammation of the kidneys (nephritis), from which abscess and other morbid alterations may result.

An affection of the kidneys, having very definite symptoms, and exhibiting uniformity of structural change, was first pointed out by Dr. Bright of Guy's Hospital, and is generally called after him. This disease is also called *Albuminuria* and *granular disease of the kidney*; the first on account of its diagnostic symptom, albumen in the urine, the second on account of the morbid condition presented by the kidney. This formidable disease presents several stages or varieties, and some discussion has taken place as to whether the symptom of albumen in the urine may not occur in several distinct morbid conditions of the kidney. There is no doubt that albumen may be found in the urine in even functional derangements of the kidney; but the term Bright's Disease is very conveniently applied to all those forms of structural change in the kidney which are accompanied with albuminous urine.

The great symptoms accompanying this disease vary according to the intensity of the disease and the condition of the patient. One of the first symptoms to which the physician's attention is usually drawn, is the presence of dropsy. This may occur in the skin or in any of the cavities of the body. It is frequently noticed in the face; and in all varieties of this disease an effusion of fluid is observed underneath the conjunctiva, producing the appearance of a watery eye. In addition to dropsical effusions, inflammatory affections of the mucous and serous membranes are very common accompaniments of Bright's Disease. The heart also is frequently affected, and pericarditis and endocarditis are observed. Affections of the brain are also not unfrequently present, especially in the more severe cases arising from the poisoned condition of the blood.

In all cases of this disease, the urine contains albumen. This is easily detected either by coagulating the albumen by heat or nitric acid. The specific gravity of the urine is also decreased, being sometimes as low as 1·010, whilst healthy urine has a specific gravity of 1·020. It contains less urea than healthy urine. Under the microscope it also presents appearances indicative of the nature of the disease. These appearances consist of casts of the minute tubes of the kidneys, formed by substances produced in various stages of the disease. They are thus classified by Dr. Bennett:—

1. *Exudative casts*, consisting of the coagulated exudation or fibrin which is poured into the tube during the inflammatory stage.
2. *Desquamative casts*, consisting of masses of the epithelium lining the tubes, and occurring in all stages of the disease.
3. *Fatty casts*, consisting of patches of epithelium as in the last, but which have undergone a fatty transformation by the accumulation of a greater or less number of fatty granules in its cells.
4. *Waxy casts*, presenting an exceedingly diaphanous and structureless substance. They are frequently associated with the two last.

Dr. Bright originally described three stages of this disease, but later observers have recognised six.

1. The catarrhal form, in which the kidneys are enlarged, and contain an increased quantity of blood. In this stage only a small quantity of urine is passed, containing the exudative and disquamative casts.
2. In this stage the kidney is enlarged to nearly double its size and is white and granular in its appearance. The tubes of the kidney are obliterated by the inflammatory deposit. The urine is very albuminous, and of light specific gravity.
3. The kidney presents a mottled appearance. It is probably a transition from the first to the second stage.
4. In this stage the kidney is large, dense, and white. The tissues of the kidney have become charged. The urine is scanty, of low specific gravity, and defective in urea and other excretory matters.
5. In this stage the kidney is hard, granular, and contracted. The kidney is smaller than in health, the surface is uneven and puckered, the tunic adherent. There is no deposit in the tubes, but fibrous matter has been deposited in the tissues of the kidney, and the tubes are strangulated. The urine may not contain albumen. Its specific gravity is sometimes as low as 1·005.
6. This stage has been called the 'coarse kidney.' The organ is large and dark. The specific gravity of the urine is high, and it is loaded with urates.

The presence of fatty matter in the casts of the kidneys may occur in any of these stages, and does not appear to exist as a separate form of the disease.

The cause of this disease is anything which will unduly excite the action of the kidney. Thus it comes on as the result of spirit drinking, which powerfully excites the action of the kidneys. Exposure to cold and diminution of the action of the skin will also produce it. It comes on frequently after scarlatina, when the skin is highly susceptible of any diminution of temperature.

The treatment must be active in the early stages. Purgatives may be given and blood abstracted locally, and the febrile symptoms treated accordingly. Mercury is not found beneficial. When chronic, diaphoretics and diuretics are both admissible. Amongst the former, Dover's powder and warm baths, and the latter, bitartrate of potash and digitalis. The patient should be protected from cold; a warm climate is serviceable; and a nutritious but not stimulating diet, with fresh air and exercise, are desirable.

The name of Dr. Addison, physician to Guy's Hospital, has been connected with a diseased condition of the system, which is made apparent by a discoloration of the skin. Hence this disease is also called 'Bronzed Skin.' The existence of this discoloured skin has long been known as a symptom of certain cachectic states of the system; but Dr. Addison was the first to point out that this state of the skin generally existed in connection with a diseased condition of the supra-renal capsules. These bodies belong to the class of ductless glands, and till the time of Dr. Addison's researches upon bronzed skin appeared, little was known of their uses and functions in the human body. The following conclusions with regard to these bodies have been arrived at by Dr. Harley as the result of his experiments:—

1. The supra-renal capsules are not solely fœtal organs.
2. They are not absolutely essential to life.
3. The removal of the right is generally more fatal than the left.
4. That convulsions do not necessarily follow their removal.
5. The absence of their function is attended neither by great emaciation nor debility.
6. If death follows an experiment, it occurs as the result of injuring neighbouring parts.
7. Absence of the supra-renal bodies is not proved to have any special effect in arresting the transformation of hæmatin, or in increasing the formation of blood crystals.
8. The suppression of the supra-renal capsular function is not attended by an increased deposit of pigment in the skin or its appendages.
9. The problem of the connection of the bronzed skin and supra-renal capsular disease is more likely to be solved in the dead-house than in the physiological laboratory.

These conclusions were chiefly arrived at by experiments on rats, but they would seem to indicate that the connection between the bronzed skin and supra-renal capsules is not clearly made out.

The distinguishing features of the disease to which the name bronzed skin has been given, are general languor and debility, great feebleness of the heart's action, irritability of the stomach, a peculiar change of colour of the skin, and these symptoms usually occurring in connection with a diseased condition of the supra-renal capsules. The general symptoms are in fact those of anæmia, or cases in which the blood is imperfectly developed. Dr. Addison says of this discoloration of the skin, that it usually increases with the advance of the disease. "The anæmia, languor, failure of appetite, and feebleness of the heart become aggravated; a darkish streak usually appears upon the commissure of the lips; the body wastes, but without the extreme emaciation and dry harsh condition of the surface so commonly observed in ordinary malignant diseases; the pulse becomes smaller and weaker, and without any special complaint of pain or uneasiness, the patient at length gradually sinks and expires. In one case, which may be said to have been acute in its development as well as rapid in its course, and in which both capsules were found universally diseased after death, the mottled or checkered discoloration was very manifest, the anæmic condition strongly marked, and the sickness and vomiting urgent; but the pulse, instead of being small and feeble as usual, was large, soft, extremely compressible, and jerking on the slightest exertion or emotion, and the patient speedily died." (Addison.)

Although the connection between the state of the skin and the disease of the capsules was exhibited in all Dr. Addison's original cases, many exceptions have been recorded. Cases have occurred in which extensive disease of the supra-renal capsules has occurred without any bronzed skin, and cases of bronzed skin have been seen where no disease of the supra-renal capsules could be detected after death.

Dr. Harley, in the paper before referred to, concludes:—

1. That bronzed skin may exist without the supra-renal capsules being diseased.
2. That complete degeneration or total absence of the supra-renal capsules may occur without any bronzing of the skin.
3. That bronzed skin may be associated with a variety of differently marked conditions of the system, among which a prominent one is disease of the supra-renal capsules.
4. That bronzed skin may be present without any derangement of

the other functions of the body being observed. ('British and Foreign Medico-Chirurgical Review,' No. 42, 1848.)

Dr. Harley is of opinion that the general symptoms of this disease are produced by a "diseased state of the solar plexus *per se*, or by irritation of the ganglionic system of nerves, caused by the close proximity and intimate connection of diseased supra-renal capsules."

The blood has been examined by the microscope in some of these cases, and found to present an increased quantity of the white blood cells, as observed in the disease known as Leucocythemia. [Blood, Diseases of.]

The microscopic character of the skin has been carefully examined in this disease, and it has been found to present the same appearance as observed in the skin of the black man. The pigmentary matter of the skin was found to be increased, and existed in larger quantities in the under than in the upper layers of the epidermis.

The treatment of this disease is not affected by our knowledge of its supposed cause. The remedies which would be applicable to bloodless and depressed conditions of the system, should be used here. Tonics, nutritious diet, fresh air, and the means resorted to for restoring health in anæmia and leucocythemia may be had recourse to here.

The prognosis in this disease is unfavourable, although cases are reported in which recovery has taken place.

Suppression of urine may be the ultimate result of obstruction from calculi in the ureters, or it may occur as an idiopathic disease. It is a condition of great danger, for low delirium and a comatose sleepy state very often supervene on it, and soon terminate fatally. Long and often repeated attacks of retention of urine from obstruction produce dilatation of the ureters and pelvis, which sometimes acquire an enormous size. There may result from the same cause a gradual absorption of the substance of the kidney, till in an advanced stage there is found nothing but a thin sac containing urine in a single cavity, or in a number of separate pouches. The kidneys are also subject, in common with other organs, to the deposition of various morbid substances, as cancer, fungus, hæmatodes, melanosis, tubercle, &c. But the diagnosis of all the chronic affections of this organ is extremely obscure, the principal indications of each being the same, viz., the dull heavy pain in the loins, dropsy, and sometimes hæmaturia.

KIN. [Descent; Intestacy.]

KING. The primary use of this word is to denote a person in whom is vested the higher executive functions in an independent state, together with a share, more or less limited, of the sovereign power. The state may consist of a vast assemblage of persons, like the French or the Spanish nation, or the British people, in which several nations are included; or it may be small, like the Danes, or like one of the states while in England there were seven states independent of each other; yet if the chief executive functions are vested in some one person who has also a share in the sovereign power, the idea represented by the word *king* seems to be complete. It is even used for those chiefs of savage tribes who are a *state* only in a certain loose and colloquial sense of the term.

It signifies nothing whether the power of such a person be limited only by his own conscience and will, or whether his power be limited by certain immemorial usages and written laws, or in any other way; still such a person is a king.

Nor does it signify whether he succeed to the *throne*, the seat on which he sits when in the exercise of his royal authority, by descent and inheritance on the death of his predecessor, just as the eldest son of a peer succeeds to his father's rank and title on the death of the parent, or is elected to fill the office by some council or body of persons selected out of the nation he is to govern, or by the suffrages of the whole nation. Thus there was a king of Poland who was an elected king; a king of England who succeeded by hereditary right.

Still, in countries where the kingly office is hereditary, some form has always been gone through on the accession of a new king, in which there was a recognition on the part of the people of his right, a claim from them that he should pledge himself to the performance of certain duties, and generally a religious ceremony performed, in which anointing him with oil and placing a crown upon his head were conspicuous acts. By this last act is symbolised his supremacy; and by the anointing a certain sacredness is thrown around his person. These kinds of ceremonies, we believe, are found in all countries in which the sovereign, or the person sharing in the sovereign power, is known as king; and these ceremonies seem to make a distinction between the succession of an hereditary king to his throne and the succession of an hereditary peer to his rank.

The distinction between a king and an emperor is not very clearly defined. *Emperor* comes from *imperator*, a title used by the sovereigns of the Roman empire. When that empire became divided, each sovereign, that of the West and that of the East, called himself an emperor. These emperors claimed a kind of supremacy over other sovereigns. The emperor of Germany was regarded as a kind of successor to the emperors of the West, and the emperor of Russia (who was and is often called the Czar), is, with less pretension to the honour, sometimes spoken of as successor to the emperor of the East. But we speak of the emperor of China, where emperor is clearly nothing more than king, and we use emperor rather than king only out of regard to the vast extent of his dominions. Napoleon I. called himself an emperor, a title revived by his nephew Napoleon III.; and we sometimes speak of the British empire. [Emperor.]

The word *king* is of pure Teutonic origin, and is found slightly varied in its literal elements in most of the languages which are sprung from the Teutonic. The French, the Italian, the Spanish, and the Portuguese, on the other hand, have chosen to continue the use of the Latin word *rex*, only slightly varying the orthography according to the analogies of each particular language. *King*, traced to its origin, seems to denote one to whom superior knowledge has given superior power, allied, as it seems to be, to *know*, *con*, *can*; but on the etymology, or what is the same thing, the remote origin of the word, different opinions have been held, and the question may still be considered undetermined.

There are two or three other words employed to designate the sovereigns of particular states, in using which we adopt the word which the people of those states use, instead of the word *king*. Thus there is the *Shah* of Persia, the *Elector* of Hesse-Cassel, the *Czar* (now more commonly styled Emperor) of Russia, and the grand *Sultan*. In the United States of America very limited powers are given to one person, who is elected to enjoy them for a short period with the title of *President*. A *Regent* is a temporary king.

A personage in whom such extraordinary powers have been vested must of necessity have had very much to do with the progress and welfare of particular nations, and with the progress of human society at large. When held by a person of a tyrannical turn of mind, these powers might be made use of to repress all that was great and generous in the masses who were governed, and to introduce among them all the evils and miseries of slavery. Possessed by a person of an ambitious spirit, they might introduce unnecessary quarrelling among nations to open the way for conquest, so that whole nations might suffer for the gratification of the personal ambition of one. The lover of peace and truth, and human improvement and security, may have found in the possession of kingly power the means of benefiting a people to an extent that might satisfy the most benevolent heart. But it must now by the long experience of mankind have become sufficiently apparent that for the king himself and for his people it is best that there should be strong checks in the frame of society on the mere personal and private disposition of kings, in the forms of courts of justice, councils, parliaments, and other bodies or single persons whose concurrence must be obtained before anything is undertaken in which the interests of the community are extensively involved. In most countries, as in England, there are controlling powers such as these, and even in countries in which the executive and legislative power are nominally in some one person absolutely, the acts of that person are virtually controlled, if by nothing else, by the opinion of the people, a power constantly increasing as the facilities of communication and the knowledge of a people advance.

Nothing can be more various than the constitutional checks in different states on the kingly power, or, as it is more usually called in England, the royal *prerogative*. Such a subject must be passed over in an article of confined limits such as this must be, else in speaking of the kingly dignity it might have been proper to exhibit how diversely power is distributed in different states, each having at its head a king. But the subject must not be dismissed without a few observations on the kingly office (now by hereditary descent discharged by a queen) [Queen], as it exists among ourselves.

The dawn of the English kingly power is to be perceived in the establishment of Egbert, at the close of the 8th century, as king of the English. His family is illustrated by the talents and virtues of Alfred, and the peacefulness and piety of Edward. On his death there ensued a struggle for the succession between the representative of the Danish kings, who for awhile had usurped upon the posterity of Egbert, and William then duke of Normandy. It ended with the success of William.

This is generally regarded as a kind of new beginning of the race of English kings, for William was but remotely allied to any of the Saxon kings. In his descendants the kingly office has ever since continued; but though the English throne is hereditary, it is not hereditary in a sense perfectly absolute, nor does it seem to have been ever so considered. For when Henry I. was dead, leaving only a daughter, named Maud, she did not succeed to the throne; and when Stephen died, his son did not succeed, but the crown passed to the son of Maud. Again, on the death of Richard I. a younger brother succeeded, to the exclusion of the son and daughter of an elder brother deceased. Then ensued a long series of regular and undisputed successions; but when Richard II. was deposed, the crown passed to his cousin Henry of Lancaster, son of John of Gaunt, son of Edward III., though there were descendants living of Lionel, duke of Clarence, who was older than John among the children of Edward III. When the rule of Henry VI. became weak, the issue of Lionel advanced their claim. The struggle was long and bloody. It ended in a kind of compromise, the chief of the Lancastrian party taking to wife the heiress of the Yorkists. From that marriage have sprung all the later sovereigns, and the principle of hereditary succession remained undisturbed till the reign of King William III., who was called to the throne on the abdication of James II., when an act was passed excluding the male issue of James, the issue of his sister the duchess of Orleans, and the issue of his aunt the queen of Bohemia, with the exception of her youngest daughter the princess Sophia and her issue, who were Protestants. On the death of Queen Anne this law of the succession took effect in favour of King George I., son of the Princess Sophia.

Now the heir succeeds to the throne immediately on the decease of his predecessor, so that the king, as the phrase is, never dies. But it is supposed that anciently there was a short intermission, and that the whole of the royal power was not possessed till there had been some kind of recognition on the part of the people.

At the coronation of the king he makes oath to three things:—that he will govern according to law; that he will cause justice to be administered; and that he will maintain the Protestant church.

His person is sacred. He cannot by any process of law be called to account for any of his acts. His concurrence is necessary to every legislative enactment. He sends embassies, makes treaties, and even enters into wars without any previous consultation with parliament. He nominates the judges and the other high officers of state, the officers of the army and navy, the governors of colonies and dependencies, the bishops, deans, and some other dignitaries of the church. He calls parliament together, and can at his pleasure prorogue or dissolve it. He is the fountain of honour: all hereditary titles are derived from his grant. He can also grant privileges of an inferior kind, such as rights of exclusive trading, and of markets and fairs.

This is but a very slight sketch of the power inherent in the kings of England; but the exercise of any or all of these powers is limited by two circumstances: first, the king cannot act politically without an agent, and this agent is not protected by that irresponsibility which belongs to the king himself, but may be brought to account for his acts if he transgress the law; and, secondly, the constant necessity which arises of applying to parliament for supplies of money gives to that body virtually such a control over the exercise of the royal prerogative, as amounts to a necessity of obtaining its concurrence in any public measure of importance. [PARLIAMENT.]

KING'S BLUE. [COLOURING MATTERS.]

KING'S EVIL. [SCROFULA.]

KING'S YELLOW. [COLOURING MATTERS.]

KINGS, THE BOOKS OF, the name of two books of the Old Testament. They originally formed only one book in the Hebrew text, and are entitled מלכים, that is, 'kings.' In the Septuagint they are divided into two books, and are entitled 'the third and fourth books of reigns' or kingdoms (*βασιλειῶν τρίτη καὶ τετάρτη*); since the first and second books of Samuel are called in this translation the first and second books of Kings.

These books contain an account of Jewish history from the death of David to that of Solomon (1 Kings, i.-xi.); an account of the division of the kingdom under his successor Rehoboam, and the history of the two kingdoms of Israel and Judah, to the conquest of the former by the Assyrians under Shalmaneser (1 Kings, xii.—2 Kings, xvii.); and the separate history of the tribes of Judah and Benjamin, till they were carried away captive to Babylon by Nebuchadnezzar in the reign of Jehoiachin. (2 Kings, xviii.-xxv.) The period covered by the two books is 455 years.

These books, in common with the books of Chronicles and many others of the Old Testament, are generally ascribed to Ezra, though the Jews give the authorship to Jeremiah or Isaiah, but neither the author nor the time in which they were written can be determined with any degree of certainty; and Biblical scholars are much divided in opinion on the subject. It is evident from many passages, and especially from the last chapter of these books, that a portion of them must have been written in the time of the Babylonian captivity; but there are also other passages which must have been written before the destruction of the kingdom of Israel, and while the temple at Jerusalem was still standing. (1 Kings, viii. 8; ix. 13, 21; x. 12; xii. 19; 2 Kings, viii. 22; x. 27; xiv. 7; xvii. 23, 34, 41.) It is therefore probable that these books are only a collection of different documents written by persons present at the events narrated, and that the compiler only wrote such portions as were necessary to connect the different documents, and to form one continuous narrative.

But though there may be uncertainty as to the writer, there is none as to the truth of the matters they record, of which the internal evidence is sufficient proof, independent of which other parts of the sacred writings bear testimony to their integrity, as Matt. xii. 42; Romans, xi. 4, &c., and our Lord, in Luke iv. 26, quotes the example of Elijah and Elisha that prophets have no honour in their own country. The Jews have uniformly accepted these writings as divinely inspired, and Christians as uniformly placed them among the canonical books.

KINIC or QUINIC ACID ($C_{28}H_{20}O_{20}, 2HO$) is obtained from cinchona bark, in the manufacture of sulphate of quinine. It occurs in the bark united with the quinine, and when lime is added to a solution of bark, a kinate of lime is formed. The kinic acid is procured from this compound by the action of oxalic acid. It forms salts with the metals, highly interesting to the chemist.

Kinic acid has a very sour, but when pure not a bitter taste; it reddens litmus paper strongly; is unalterable in the air, dissolves in 2½ times its weight of water at 48°, and is also soluble in alcohol. When heated in a retort it readily fuses, boils up, decomposes, blackens, and yields an empyreumatic oil, with pungent vapours of *pyrokinic acid*, one portion of which condenses into a liquid, and another crystallises. Sulphuric acid renders kinic acid first green, and then carbonises it; by the addition of a small portion of nitric acid it is converted into an acid resembling the pyrokinic acid, which may be sublimed; but a large quantity of nitric acid changes it into oxalic acid.

The natural kinates, except that of lime already mentioned, are only obtained by complicated processes from the bark; but by artificial means they are readily procured, either by saturating the acid with the bases, or by the double decomposition of kinate of baryta and the sulphates of such bases as form soluble sulphates. We shall describe only a few kinates, and chiefly those which exist in the cinchona, and first we shall notice the most important of them, the

Kinate of Quinine.—The natural salt crystallises with difficulty, on account of the admixture of yellow colouring and other matters, and these have prevented the determination of its crystalline form. This salt is very bitter, readily soluble in water, and but slightly so in alcohol of sp. gr. 0·837. It is decomposable by heat, without residue. By evaporation the solution is reduced to a viscid paste, which, when moistened and exposed to the air, exhibits rudiments of crystallisation. It is, like other salts of quinine, decomposed by the alkalies ammonia, potash, and soda, which precipitate the quinine. Kinate of quinine may be formed artificially by dissolving quinine recently precipitated from the sulphate in a solution of kinic acid, with a gentle heat. By exposure to the air the liquid becomes a mammellated mass, containing small brilliant rhombic crystals of kinate of quinine.

Kinate of Cinchonine.—The natural compound very much resembles that of quinine; the artificial salt yields crystals by exposure to the air, which are like, but are more distinct than, those of the kinate of quinine obtained in the same way. This salt is bitter, very soluble in water, and slightly so in alcohol of sp. gr. 0·837.

Kinate of Lime ($C_{28}H_{20}CaO_{22} + 20$ aq.)—This salt crystallises in rhomboids and hexagonal plates; it has but little taste; it is soluble in six times its weight of water at 60°, and much more so in boiling water. It is insoluble in alcohol. It is decomposed by oxalic acid and sulphuric acid, and also by the alkaline carbonates. According to Berzelius, a small quantity of kinate of lime may be obtained from the alburnum of the fir-tree.

The properties of the artificial kinates are thus, with slight alterations, given by Berzelius. *Kinate of potash*, bitter and deliquescent. *Kinate of soda* crystallises in hexahedral prisms; it appears to contain no water of crystallisation, and does not alter by exposure to the air. *Kinate of ammonia*, deliquescent. By evaporation a portion of its acid is set free. *Kinate of baryta* crystallises in dodecahedrons with triangular faces; becomes opaque by exposure to the air; is very soluble in water, but slightly so in alcohol of 0·830. *Kinate of magnesia*, very soluble, and forms crystalline excrescences similar to cauliflowers. *Kinate of manganese* crystallises in rose-coloured lamellar crystals. *Kinate of zinc* crystallises in laminæ, or in cauliflower-like aggregations. *Kinate of nickel*, a green gummy mass, very soluble in water. *Perkinate of iron*, a reddish-yellow gummy mass, soluble in water. *Kinate of lead* crystallises in slender needles, which do not alter by exposure to the air, and are soluble in alcohol. *Subkinate of lead*, a white powder insoluble in water. *Kinate of copper* crystallises in green needles, or rhombic laminæ; the surface becomes white by exposure to the air. *Perkinate of mercury*, a colourless salt which does not crystallise. *Kinate of silver* forms mammellated crystals, which readily blacken in the light.

When kinic acid or kinate of lime is distilled with sulphuric acid and peroxide of manganese, a new compound called *kinone*, or *kinöil*, is obtained. It occurs in crystals of a fine golden-yellow colour, which are soluble in water, having a pungent smell when in the state of vapour. When kinone is acted on by reducing agents, it takes up 2 and 4 equivalents of hydrogen, forming *green* and *white hydrokinone*. The first forms green crystals of exceeding beauty; the latter are white. Wöhler has obtained several compounds of kinone, of which the following tabular statement gives the names as far as they are yet known:—

Kinone	$C_{12}H_4O_4$
Green hydrokinone	$C_{12}H_4O_4, C_{12}H_6O_4$
White hydrokinone	$C_{12}H_6O_4$
Chlorohydrokinone	$C_{12}H_5ClO_4$
Chlorokinone	$C_{12}H_3ClO_4$
Kinonic acid	$C_{12}H_4O_8$
Trichlorokinone	$C_{12}HCl_3O_4$
Perchlorokinone, or chloranil . . .	$C_{12}Cl_4O_4$

KINO, an astringent substance, the concrete juice of one or more plants. Most skilful pharmacologists are agreed in referring the East India kino, called also Amboyna kino, to the *Pterocarpus marsupium* (Roxb. 'Coromand. Plants,' ii., t. 116; 'Fl. Indica,' iii., p. 234), of which *Pterocarpus bilobus* is perhaps a mere variety, though a smaller tree. The first is a native of the Circar Mountains, and forests of the Malabar coast. No kino is imported at the present day from Africa, though the juice of *Pterocarpus crenaceus* is collected by the Senegambians for their own use in medicine and the arts. It is quite a misnomer to term the inspissated juice of the *Nauclea* (*Uncaria*) *gambier*, or *gambear*, African kino, as this shrub grows in the Indian Archipelago.

In Australia a sort of kino is procured from the *Eucalyptus resinifera* (White), which finds its way to the East Indies, where it is used as a cotton-dye, as indeed the other kinds are also, giving to cotton the yellowish-brown colour known as nankeen; the colour varies with the different sorts of kino used.

In the West Indies the juice of the *Coccoloba uvifera* is called American kino, or American extract of rhatany, or false rhatany extract. These different extracts differ in their chemical habitudes with re-agents, but they all agree in possessing a stong astringent power. Kino most commonly occurs in grains of a shining aspect and rich ruby-red colour; they are easily reduced to powder. It is nearly entirely soluble in water and in alcohol. Vauquelin analysed that sort which is termed African, and found it to consist of 75 per cent. of tannin, 24 of red mucilage, and 1 of woody fibre. [TANNIC ACID.]

Some of the kino of commerce is no doubt produced by *Butea frondosa*, which is common as a tree or shrub in every part of India. On comparing together specimens of the astringent gum of this plant, contained in Dr. Royle's collection, with some brought from North-western India by Mr. Beckett, and both these with some sent from Bombay as the kino of the *Butea frondosa*, they were all three found to be identically the same kind of gum; but Mr. Beckett's, from being the freshest specimen, was the most highly coloured. These were all moreover found to correspond, especially the specimens from Bombay, with some astringent gum found by Mr. Pereira in one of the old druggists' shops of London, under the name of *Gummi rubrum astringens*, which was the name by which kino was known. It was introduced into practice by Dr. Fothergill as *Gummi astringens Gambiense*. It is remarkable that the Sanskrit name of *Butea frondosa* is *kinsuka*. From its gum being labelled by a druggist as Gummi rubrum astringens, it is evident it must have been among the earliest substitutes for the African kind, of which so little has ever been imported into this country. Analysed by Mr. E. Solly, jun., the Butea kino was found to contain between 60 and 70 per cent. of tannin with gum. It is curious that Dr. Roxburgh remarks of the gum of the *Butea frondosa*, that it is so like that of his *Pterocarpus marsupium* that one description might suffice for both, with respect as well in appearance as to the action of chemical re-agents.

KINONE. [KINIC ACID.]

KINONIC ACID. [KINIC ACID.]

KINONIC GROUP (*Quinonic Group*), one of the groups of organic bodies belonging to the Benzoic series of Gerhard's system of classification. Several of the bodies belonging to this group are produced by the metamorphosis of phenylic alcohol, and of salicylic, and indigotic compounds. They are however usually prepared from the kinic acid contained in cinchona bark. The following are the principal bodies belonging to this group:—

Kinic acid	$C_{28}H_{22}O_{22}$
Kinone	$C_{12}H_4O_4$
Hydrokinone	$C_{12}H_6O_4$
Kinonic acid	$C_{12}H_4O_8$
Kinonamide	$C_{12}H_6N_2O_4$
Kinonamic acid	$C_{12}H_5NO_6$

KINOTANNIC ACID. [TANNIC ACIDS.]

KINOVATIC ACID ($C_{38}H_{30}O_{10}$) *Kinovic Acid*. A peculiar acid found in cinchona bark, and also produced by the action of acids and alkalies upon cäincic acid. [CÄINCIC ACID.]

KINOVIC ACID. [KINOVATIC ACID.]

KIRK SESSIONS. [SESSIONS, KIRK.]

KIRSCHWASSER. A kind of spirit prepared in the Vorarlberg from cherries.

KITCHEN-GARDEN. Every one knows what is generally understood by this name, a kitchen-garden forming a sort of inseparable adjunct to every country-house, to the mansion of the rich as well as to the humble cottage. In laying out the grounds of a country residence provision should be made for the site of the kitchen-garden. Though it should not obtrude on the ornamental ground immediately adjoining the house, the design of the whole should be so formed as to leave the kitchen-garden in the most favourable situation with regard to aspect, soil, and water. The aspect should be open to the south, but sheltered on other sides, more especially from northerly and easterly winds, by rising ground or lofty trees at some distance. The surface should be nearly level, or in some cases, according to the pervious nature of the subsoil, it may be quite so; but, generally speaking, a gentle slope from north to south is best. The soil should consist of a rich loam, neither too light nor so adhesive as to be liable to bind strongly in dry weather. The depth of soil ought not to be less than two feet, and more is absolutely necessary for some kinds of vegetables. If the subsoil be very impervious it should be sub-trenched; and in doing this the undisturbed bottom of the whole area should form a regularly inclined plane towards a proper drain; or if more convenient the bottom may form several planes so inclined as to allow the water a descent to a drain running through the lowest points. In the formation of gardens this is frequently not sufficiently attended to; while care is taken that the surface of the soil should be fair to the eye, a comparatively unimportant circumstance. If the bottom be made as above directed, the most important and difficult part of the groundwork is accomplished.

Water is very frequently obtained by means of pumps placed in convenient situations throughout the garden; but this is not the best mode of supply, nor should it be resorted to except where there is no alternative. Much injury is done to vegetation by watering with cold spring water, or indeed with any water that is much colder than the soil and atmosphere in which the plants are placed. Plants, when not watered at all in dry weather, if they are only kept alive, succeed better when rain does come than others that are watered, or rather chilled with water at a comparatively low temperature. The injurious effects of chilling plants by the application of very cold water is often visible in plants of the cabbage kind. After being transplanted from the seed-beds a quantity of cold water is immediately poured round their roots, the surrounding dry soils absorbs a great portion of this supply, the remainder is soon exhaled by evaporation, and the process is again repeated. Sudden extremes of heat and cold, moisture and dryness, derange the functions of the spongioles and roots; obstructions supervene, and occasion an accumulation of matter in the thicker parts of the root, which is the principal cause of what is called *clubbing*, or the formation of protuberances in cabbage-roots, a disease which proves a check to their future development by incapacitating their roots for a due transmission of nourishment. Water for the kitchen-garden should therefore be derived from ponds or large reservoirs fully exposed to the sun, and even these should be supplied by open rather than underground channels; they should also be shallow, for the following reason—the deeper the water the longer will a considerable portion next the bottom retain the temperature of its greatest density, about 40° Fahr. When the general temperature of water is above this the warmest is next the surface; and therefore the flow of water for the garden should be from the surface of the pond or reservoir. This may easily be effected by means of a floating or float-controlled sluice. When a broad sheet of water cannot be obtained for the supply of a garden some advantage will be gained by providing large cisterns in which water raised by pumps may be exposed to the air for some time previous to its being used.

The quantity of ground which a kitchen-garden should contain must be regulated according to the number of individuals which it is required to supply. An acre is calculated to afford a tolerable supply for sixteen individuals, but much depends on the nature of the vegetables required. Potatoes, turnips, peas, and carrots are frequently obtained of better quality and at less expense from a field than from a garden. With respect to potatoes in particular, only early varieties are now generally cultivated in gardens. If the mansion be only fully occupied for a part of the season, the quantity of ground will require to be nearly as much as if the supply were required throughout the year. Thus for example, a considerable breadth may be found necessary for peas in spring, and the same may be occupied with broccoli in autumn; so that the ground which would be sufficient for a few months' demand may be made equally so for the whole season by a proper succession of crops. For similar reasons it will be found that where a steady supply is required, proportionably less ground will be requisite than when the demand alternately exceeds and falls short of the mean.

A moderate establishment will require two acres of kitchen-garden, and a large one five or six; and in either case it may be found necessary to have recourse to field culture for those productions to which that mode of rearing is more especially adapted.

The form of a kitchen-garden should be composed of straight lines. If rectangular, it will prove a saving of labour; for it is practically known that more time is required to trench a piece of ground of a triangular form, than if the same extent were in the shape of a square or parallelogram; and besides, labourers who may not happen to be accustomed to the method of working such figures as have inclined sides are liable to make the surface irregular. A range of forcing-houses is generally placed on the north side; and as the wall on that side is the most valuable for fruit-trees on account of its direct south aspect, it becomes desirable that it should be extended as much as possible on each or both ends of the range. The form of the kitchen-garden is consequently determined to be that of a parallelogram with the two long sides running due east and west. The melon-ground, containing also pits for culinary forcing, should form an adjoining compartment well sheltered and excluded from the view on account of the quantities of litter and other fermenting substances which it must necessarily contain.

It is found that grapes ripen better against a very high wall than they do when trained on a low one. The conclusion to be drawn from this fact must be, that a greater accumulation of heat will take place in front of a wall 12 feet high than where the height is less, and consequently the trees, whilst they have space for a greater extension, enjoy an increased degree of warmth. Therefore it will be desirable that the walls of a kitchen-garden should not be less than the height above mentioned, with the exception of the one on the south, which may be only 10 feet, because it will occasion less shade; and if the wall on the opposite or north side be made 14 feet high instead of 12 feet, greater utility and a better effect will result. Once erected, walls are too valuable to be left unoccupied, and a border should accordingly be formed outside, as well as inside, for the reception of fruit-trees to be trained against them. This requires the enclosure of a slip, containing the wall-border, a walk, and a border between the latter and the outside fence. If this outside or *ring-fence* were formed of materials on which young trees could be trained, so as to fill any accidental vacancy that may occur on the principal walls, great advantages would accrue, for then the walls would always appear filled with trees in a bearing state. Such nursery trees should be carefully moved every second year, so that they may always be in a proper condition for their final destination.

The interior departments of the kitchen-garden are usually bounded by fruit-trees planted within two or three feet of the walks. Not only are bushes, such as gooseberries, currants, and raspberries, used for this purpose, but fruit-trees of various kinds. The latter are trained either as dwarfs by grafting apples on paradise stocks, and pears on quinces, and causing their branches to proceed from near the ground; or as espaliers. The latter were formerly more in use for training fruit-trees in kitchen-gardens than they are at the present time. Some object to their appearance, others to their expense compared with their utility. Their appearance is certainly not unsightly if they are not made too high; and although the old varieties of fruit-trees trained upon this plan were unprofitable, yet many of the new kinds will produce abundantly. They occupy very little space, and their shade, if not made higher than six feet, can be scarcely injurious, especially as it can be made to fall chiefly on the walk.

Very few of the subjects of kitchen-garden cultivation are indigenous; they are chiefly varieties of luxuriant habits, which are artificially maintained and augmented by the art of the cultivator. The principal means employed for rendering the soil of the kitchen-garden subservient to this purpose are,—the application of abundance of manure; trenching, digging, and otherwise stirring the soil; and a due rotation of crops. Manure supplied in abundance will generally produce luxuriance in vegetables, although sometimes a disagreeable rankness is communicated to the flavour. This is in a great measure corrected by trenching, which becomes occasionally highly necessary; and although expensive, it will always repay the cost, if judiciously performed, particularly if the soil be of a consolidating nature. Trenching exposes fresh soil, and gives rest to that which has been partially exhausted on the surface; it renders the soil pervious to water and air, and likewise for the roots of the plants; in wet weather the latter are free from stagnant moisture; and in drought they seldom suffer, because they have been able to penetrate the soil so far as to be beyond the reach of dryness. Moreover, if a thermometer is plunged in well loosened soil, after a few days of hot sun in March, it will be found to indicate a temperature many degrees above that in more compact earth, or where the soil has not been stirred for several years. The advantage of this communication of heat is obvious, especially when it is borne in mind that a number of kitchen-garden plants are natives of countries possessing a warmer soil and climate than those of Britain.

It is always advantageous to attend to a proper rotation of crops, especially where manure is not abundantly applied, nor trenching performed. One kind of plant should not immediately follow another of the same nature, or one closely allied. The selection of the plants or vegetables grown must depend wholly on the tastes and requisitions of the owners, but we may add that many of the commoner vegetables are most profitably raised by field cultivation.

(Lindley, *Theory and Practice of Horticulture*, 1855; Loudon, *Encyclopædia of Gardening*, 1850.)

KLAPROTHIUM. [CADMIUM.]

KNIGHT, KNIGHTHOOD. During the prevalence of the feudal system, when the military strength of the nation was measured by the number and efficiency of the knights whom the sovereign was able to summon to the field, a regular supply of persons qualified to perform in an effectual manner the services annexed to their tenures was a matter in which the public as well as the crown were deeply interested; and the common law adopted that part of the feudal system which enabled the king, by process of distress [DISTRESS], to compel those who held knight's fees [KNIGHT'S FEES] to take upon themselves the order of knighthood, or, in other words, to prove, by their reception into that order, that they had received the training and possessed the arms and accoutrements, and were, as to other requisites, qualified to take the field as knights. The statute, or rather the grant of 1 Edward II., enrolled in parliament, called "Statutum de Militibus," appears to have been made, partly as an indulgence upon the commencement of a new reign, and partly for the purpose of removing some doubts which existed as to the persons liable to be called upon to receive knighthood. The king thereby, in the first place, granted a respite until the following Christmas to all those who ought to have become, but were not, knights, and were then distrained *ad arma militaria suscipienda*. Further, it directed that if any complained in Chancery that he was distrained and had not land to the value of 40*l.* in fee, or for term of his life, and was ready to verify that by the country (that is, by the decision of a jury), then some discreet and lawful knights of the county should be written to, in order to make inquisition of the matter; and if they found it to be so, he was to have redress, and the distress was to cease. Again, where a person was impleaded for the whole of his land, or for so much of it that the remainder was not of the value of 40*l.*, and he could verify the fact, then also the distress was to cease till that plea was determined. Again, where a person was bound in certain debts atterminated in the exchequer at a certain sum to be received thereof annually (that is, respited, subject to payment by instalments), and the remainder of his land was not worth 40*l.* per annum, the distress was to cease till the debt was paid. No one was to be distrained *ad arma militaria suscipienda* till the age of twenty-one, or on account of land which he held in manors of the ancient demesne of the crown as a sokeman, inasmuch as those lands were liable to pay a tallage when the king's lands were tallaged. With respect to those who held land in socage of other manors, and who performed no *servitium forinsecum*, or service due upon the tenure, though not expressed in the grant, the rolls of chancery in the times of the king's predecessors were to be searched, and it was to be ordered according to the former custom; the same of clerks in holy orders holding any lay fee, who would, if laymen, have been liable to become knights. No one was to be distrained in respect of property of burgage tenure. Persons under obligations to become knights, who had held their land only a short time, were extremely old, or had an infirmity in their limbs, or had some incurable disease, or the impediment of children, or law-suits, or other necessary excuses, were to appear and make fine before two commissioners named in the act, who were to take discretionary fines from such disabled persons by way of composition. Under this regulation, those who were distrained upon as holding land of the value of 40*l.* per annum either received knighthood or made fine to the king. The alteration in the nominal value of money occasioned by the increased quantity of the precious metals, and still more by successive fraudulent degradations of the standard, gradually widened the circle within which estates were subjected to this burden; and in the 16th and 17th centuries lands which in the reign of Edward II. were not perhaps worth 4*l.* per annum, had risen in nominal value to 40*l.*, and were often held by persons belonging to a totally different class from those who were designated by 1 Edward II., stat. 1, as persons having 40 *libratas terræ*.

That power of compelling those who refused to take upon themselves the order of knighthood, or rather of distraining them till they received knighthood, or compounded with the king by way of fine, which originally was a means of enforcing the performance of a duty to the crown and to the public, by persons holding a certain position and having a certain stake in the country, was perverted into a process for extorting money from those who would have been exempt at common law, which regulated the amount of a knight's fee by the sufficiency of the land to support a knight, and not by its fluctuating nominal value in a debased currency. This oppressive, if not dishonest proceeding, which was occasionally resorted to in the reigns of Edward VI. and Elizabeth, was reduced into a system by the rash advisers of Charles I., and was adopted by that unfortunate prince as one of the modes by which money might be raised without resorting to a parliament for assistance. The undisguised manner in which this ancient prerogative was thus abused, led to its total abolition. By 16 and 17 Car. I., c. 20, it is enacted, that none shall be compelled, by writ or otherwise, to take upon him the order of knighthood, and that all proceedings concerning the same shall be void.

Persons have been required to take upon themselves the order of knighthood as a qualification for the performance of honourable services at coronations, in respect of the lands which they held by grand serjeanty.

Knighthood in England is now conferred by the king (or queen when the throne is filled by a female) by simple verbal declaration attended with a slight form, without any patent or other written instrument. Sometimes, but rarely, knighthood is conferred on persons who do not come into the presence of royalty. This is occasionally done to governors of colonies, and other persons in prominent stations abroad. The lord-lieutenant of Ireland has a delegated authority of conferring this honour, which is very sparingly exercised.

Knighthood gives to the party precedence over esquires and other untitled gentlemen. "Sir" is prefixed to the baptismal name of knights and baronets, and their wives have the legal designation of "Dame" which is ordinarily converted into "Lady." Knighthood is, however, not hereditary, but merely personal.

A rank correspondent to our rank of knighthood has been found in all Christian countries. Some regard it as a kind of continuation of the equestrian order among the Romans. But it is safer to regard it as originating in Christian times; and the 11th and 12th centuries have been named as the period to which the order of knighthood as now existing may be traced. In such an inquiry there are two difficulties: first, to state with sufficient precision what is the thing to be proved; and, secondly, to obtain evidence of the commencement of an institution which probably grew, almost insensibly, out of a state of society common to the whole of civilised Europe.

It was a military institution, but there appears to have been something of a religious character belonging to it, and the order of knighthood, like the orders of the clergy, could be conferred only by persons who were themselves members of the order.

In early times some knights undertook the protection of pilgrims; others were vowed to the defence or recovery of the Holy Sepulchre. Some, knights-errant, roved about "seeking adventures,"—a phrase not confined to books of romance, of which there are many on this subject, but found in serious and authentic documents.

But besides those who are simply knights, there are knights who are members of particular orders or classes.

These orders are found in most of the kingdoms of modern Europe, and have had generally for their founder a sovereign prince. Such are the order of the Golden Fleece, instituted by Philip, duke of Burgundy; the order of the Holy Ghost, instituted by Henry the Third of France; the order of St. Michael, instituted by Louis the Eleventh of France. Of the foreign orders, which are very numerous, the most recent account will be found in a work entitled 'A Concise Account of the Several Orders of Knighthood, and other marks of honourable distinction,' by Nicholas Carlisle, 8vo, 1839. Foreign orders cannot be worn by British subjects without the special consent of the sovereign. Each of these orders has its peculiar badge, ribbons, and other decorations of the person. The British orders are the Garter and the Bath, (which are treated of under the heads of GARTER, KNIGHTS OF THE, and BATH, KNIGHTS OF THE), the Thistle, and St. Patrick.

The order of the Thistle was instituted in 1540, by James V. of Scotland; but it fell into decay, till in the reign of Queen Anne, 1703, it was revived. The number of knights was limited to thirteen, but in 1827 the number was increased to sixteen, all of whom are nobility of Scotland.

The order of St. Patrick was instituted in 1783. The knights were fifteen, increased in 1833 to twenty-two, who are peers of Ireland.

There are also knights of the Guelphic order, and knights of the Ionian order of Saint Michael and Saint George. Carlisle mentions an African order of the Palm and Alligator, instituted by the kings of Soudan.

KNIGHT OF THE SHIRE is the designation given to the representatives in parliament of English counties, as distinguished from such cities and towns as are counties of themselves (which are seldom, if ever, called shires), and the representatives of which, as well as the members for other cities and towns, are denominated citizens or burgesses. Though the knights of the shire always sat with the citizens and burgesses as jointly representing the third estate of the realm, as well during the time that the three estates, viz. the spiritualty, the lords temporal, and the commons, sat together, as since, we find that grants were occasionally made by the knights to be levied on the counties, whilst separate grants were made by the citizens and burgesses to be levied upon the cities and boroughs. ('Rot. Parl.') The wages payable to knights of the shire for their attendance in parliament, including a reasonable time for their going up and coming down, were four shillings a day, being double what was received by citizens and burgesses. At the close of every session the king, in dismissing them to their homes, informed them that they might sue out writs for their wages, upon which each knight separately obtained a writ out of Chancery directed to the sheriff mentioning the number of days and the sum to be paid, and commanding the sheriff to levy the amount. Upon this the sheriff, in a public county court, divided the burden amongst the different hundreds and townships, and issued process to levy the amount, which, to the extent of the money levied, he paid over to the knight. The lands of the clergy, as well regular as secular, were exempted from contributing towards these expenses, because the clergy formed a distinct estate, and were represented in parliament by their prelates and the procuratores cleri, although the latter were, as Lord Coke expresses it, voiceless assistants only. All lay fees within the county were liable to contribute, except lands belonging to the lords and their men. The lords insisted that this exemption extended to every freeholder who held land within their baronies, seigniories, or manors, alleging that they served in parliament at their own expense for themselves and their tenants. And such was undoubtedly the practice; as by the Parliament Roll it appears that the commons frequently petitioned that the exemption should be confined to such lands as the lords kept in their own hands and occupied by their farmers or by their bond-tenants, or villeins. These requests however were met either by a simple refusal or by a statement by the king that he did not mean to lessen the liberties of the lords. If however a lord purchased land which had previously been contributory to the knight's wages, the liability continued. Freehold lands, held either by knight's service or in common socage, were liable to this burden, but customary tenures in ancient demesne and tenures in burgage were exempt. In the county of Kent no socage land was contributable, the whole burden being thrown upon those who held knight's fees, an anomaly against which the commons preferred many ineffectual petitions. Knights of the shire, and also their choosers, were formerly required to be persons either resident or having a household in the county. This regulation, though confirmed by several statutes, had fallen into neglect long before it was formally abrogated in both its branches by 14 George III., c. 58. ('Rot. Parl.')

As to the qualifications of electors, and the disqualifications from sitting as knights of the shire, see PARLIAMENT.

KNIGHT'S FEE was land of sufficient extent and value to support the dignity of a knight, granted by the king, or some inferior lord, upon the condition that the grantee and his heirs should either perform the service of a knight to the grantor and his heirs, or find some other person to do such service. The quantity of land capable of supporting a knight naturally varied according to its quality and situation; and even the amount of income sufficient to meet the charges of a knight would fluctuate according to time and place. It is not therefore surprising that we find a knight's fee sometimes described as consisting of 800 acres, sometimes of 680; sometimes estimated at 15*l.* sometimes at 20*l.*, and in later times at 40*l.* per annum. If the owner of a knight's fee deprived himself of the possession of part of his land by subinfeudation he remained liable to the feudal burden attached to the tenure of the whole.

KNIGHT'S SERVICE, TENURE BY, otherwise called tenure in chivalry, or per service de chivaler, per servitium militare, was, from the times immediately succeeding the Norman Conquest in the 11th century to the period of the civil war in the 17th, considered the first and the most important, as it was also the most general, mode of holding land in England. The land thus held was said to consist of so many knight's fees, feoda militis, that is, so many portions of land capable of supporting the dignity of a knight. [KNIGHT'S FEE.] He who held an entire knight's fee was bound by his tenure, when called upon so to do, to follow his lord to the wars (under certain restrictions as to the place at which the service was to be performed), and to remain with him forty days in every year, or to send some other knight duly qualified to perform the services. From the owner of half a knight's fee twenty days' attendance only could be required; and the obligation attaching to the quarter of a knight's fee was satisfied by the performance of ten days' service. On the other hand, a person holding several knight's fees, whether forming one or several estates, was bound to furnish a knight in respect of each.

Besides this permanent liability to military service, the tenant was subject to other occasional burdens. The principal of these are the following incidental services:—First, *Aids*, or payments which the vassal holding by knight's service was bound to make for ransoming his lord's person if taken prisoner; for making the lord's eldest son a knight; and for marrying, that is, providing a marriage portion for the lord's eldest daughter. Secondly, *Reliefs*, being a payment made by the heir in the nature of a composition for leave to enter upon land descending to him after he had attained his full age. Thirdly, *Primer Seisin*, or the right of the crown, where the lands were held of the king, to a year's profit of land descending to an heir who was of full age at the time of the death of his ancestor. Fourthly, *Wardship*, or the right to the custody of the body and lands of an heir to whom the land had descended during his minority, the king or other lord in such case taking the profits of the land during the minority to his own use, or selling the wardship to a stranger if he thought proper. Fifthly, *Marriage*, or a right in the lord, where the land descended to an heir within age, to tender to him or her a wife or a husband; and if the heir refused a match without disparagement, that is, without disparity of rank, crime, or bodily infirmity, the lord became entitled to hold the land as a security for payment by the heir of the amount for which the lord had sold or which he might have obtained for the marriage. Sixthly, *Fines upon Alienation*. To these Blackstone adds a seventh, *Escheat*, or the returning of the land to the lord upon the felony or forfeiture of the tenant, or his dying without heirs. [ESCHEAT.] But escheat is not peculiar to tenure by knight's service.

This system, which Blackstone justly characterises as a complicated and extensive slavery, fell to the ground during the existence of the Commonwealth; and the abolition of this species of tenure was confirmed upon the Restoration, as it would have been absurd and dangerous to attempt a renewal of such oppressive burdens. Accordingly, the 12th Car. II., c. 24, takes away tenure by knight's service, whether the lands are held of the crown or of a subject, together with all its oppressive fruits and peculiar consequences, and converts every such tenure into free and common socage. [SOCAGE.] Nothing can be more comprehensive than the terms of this act; besides generally abolishing tenure by knight's service, and its consequences, it descends into particulars, with a redundancy of words, which appear to indicate an extreme anxiety to extirpate completely all the evils which the legislature had under contemplation. The statute, after taking away the court of wards and liveries, enumerates wardships, liveries, primer seisins or ousterlemains, values and forfeitures of marriages, and fines, seisures, and pardons for alienation, and sweeps away the whole. But rents certain, heriots [HERIOT], suit of court and other services incident to common socage, and fealty [DISTRESS], and also fines for alienation due by the customs of particular manors, are preserved. Reliefs for lands, of which the tenure is converted into common socage, are saved in cases where a quit-rent is also payable.

KOENLITE. A fossil hydrocarbon resembling paraffin.

KORAN. [MOHAMMED, in BIOG. DIV.]

KOUMISS. *Kumiss.* A kind of spirit distilled by the Arabs from mare's milk which has undergone fermentation in leathern bags. The alcohol it contains is derived from sugar of milk.

KOUSSO, or COSSO. Under these names are comprehended the flowers and flower-stalks of a tree, native of Abyssinia, long celebrated among the natives for its anthelmintic properties. The earliest notice of it among European writers was by Leutholf, in 1681 ('Hist. Æthiopica,' lib. I., c. ix, sect. 31); but the first representation of it occurs in Bruce's 'Travels' (vol. v., p. 73, of London edition, 1790). By him it was proposed to call the tree *Banksia Abyssinica*, a generic name untenable as having been previously appropriated to a New Holland genus. *Hagenia*, applied to it by Lamarck, is for the same reason untenable. The universally admitted name is *Brayera anthelmintica*, Kunth (D. C. 'Prod.' ii., p. 588), [NAT. HIST. DIV.]; also, Richard, 'Tentamen Floræ Abyssinicæ,' pl. 48. Dr. Beke says that the tree in the Amharic language is called *kosso*, and in that of Tigre *hhàbbe*; and these same names are respectively applied to the tape-worm, against which this drug is esteemed a remedy. It flourishes best on the table-land in the north-eastern part of Abyssinia, at the height of six or seven thousand feet above the level of the sea. It is a rosaceous plant, though by Theodor d'Abbadie ascribed to the *Malvaceæ*. The flowers and flower-stalks are collected before the seeds are quite ripe, whilst still a number of florets remain unchanged. They are suspended in the sun to dry, and if not required for immediate use, are deposited in a jar. The dried portions are sent first to Egypt, thence to Constantinople, and Europe; perhaps some come to Aden.

The chemical analysis yields a fatty oil, wax, bitter acrid resin, tasteless resin, two kinds of tannin, ashes, gum-sugar (Wittstein). Martin gives also a crystalline substance termed kwoseine; there is also a little volatile oil. Owing to the high price adulteration is much practised, chiefly with pomegranate bark. To avoid this the kouso should be purchased in the entire, not powdered, state. About half an ounce is the dose for an adult. This is to be infused in half a pint of tepid water for a quarter of an hour, a little lemon-juice may be added, and about a third swallowed; then after an hour another third, finally the remainder, with lemon-juice. This seems to check the disposition to vomiting caused by the nauseous taste and odour. At the end of four hours, a dose of castor-oil or infusion of senna may be given. By the action of this last tape-worms, either entire or in part, mostly dead, are brought away. The chief recommendation of kousso over other anthelmintics seems to be that under its influence the head as well as the joints of the parasite are brought away. Without this be effected any amendment can only be temporary. The fullest account of kousso, in English, is by Dr. Pereira, in 'Journal of Pharm. Society,' vol. x. p. 15, now incorporated in Pereira's 'Mat. Med.' [ANTHELMINTICS.]

KRAME'RIA TRIANDRA, or RHATANY, is a small low-lying undershrub, growing on the dry projecting parts of the mountains of Peru, near Huanaco, &c. The native name is Rhatanhia. The root, which is the officinal part, is from four to eight inches long, and from the size of a writing quill to two inches thick, with knotty but not strong ramifications, and is very variable in shape. The bark is thin, uneven, and easily separates from the woody part. The bark bears a larger proportion to the woody part in the young than in the old ramifications, and contains more astringent matter. The young ones are to be preferred. The root is heavy, and devoid of odour; but the taste, especially of the bark, is strongly astringent and bitter, yet not disagreeable. Iodine turns it black. According to the analysis of Gmelin, it contains much tannin, with saccharine and mucilaginous matter, woody fibre, and salts. According to Peschier, it contains krameric acid. This root, from which, in Peru, an extract is formed, is a mild, easily assimilated, astringent medicine, possessed of great power in passive bloody or mucous discharges; and also in weakness of the digestive organs, muscular debility, and even in intermittent and putrid fevers. The powder forms, along with charcoal, an excellent tooth-powder; and an infusion is used as a gargle and wash. The chief use of the extract imported from South America, is said to be the adulteration of port wine.

KRAMERIC ACID. A peculiar acid of unknown composition, said to exist in the extract of Rhatany (*Krameria triandria*). It is a non-volatile, difficultly crystallisable solid.

KREASOTE. [CREOSOTE.]

KREATINE. Synonymous with creatine. [CREATINE.]

KREATININE. [CREATININE.]

KRESYLIC ACID. Synonymous with *hydrate of cresyl*. [CRESYL.]

KRISHNA. [VISHNU.]

KRONOS, one of the most ancient of the Greek gods, the youngest of the Titans, and father of Zeus. Kronos was the son of Uranus and Gæa. Uranus, who was ruler of the world, out of fear or hatred of his children, especially of the Cyclopes, cast them into Tartarus and kept them imprisoned there. In revenge Gæa incited the Titans to rebel against their father, and gave to Kronos a sickle (ἅρπη) of adamant, with which he deprived his father of virility. Uranus being deposed, Kronos was raised to his throne, and the Cyclopes liberated; but they were again cast by Kronos into Tartarus. Kronos now married his sister Rhea, and had by her Hestia, Demeter, Hera, Hades, Poseidon, and Zeus; but it having been foretold him by Uranus that he should be deposed by one of his children, he swallowed all of them but Zeus as soon as they were born. On the birth of Zeus, Rhea gave Kronos a stone wrapped in a cloth, which he swallowed, believing it to be his newly born child. Rhea concealed her son in a cave in Crete, where he passed the first years of his life. When Zeus grew up, Kronos, in order to secure his throne, called the Titans to his aid; but Zeus, by the counsel of Thetis, administered a potion to Kronos, which caused him to bring up the children he had swallowed. Zeus, with his brothers and sisters, now attacked the Titans, who, after a contest which lasted ten years, and which was known to the Greeks as the Titanomachia, were eventually conquered, and Kronos was dethroned.

In Greek art Kronos is often represented with a veil covering the back of his head; and almost always with the harpe, or sickle, in his hand. Sometimes he is figured enthroned, with Rhea offering him the stone; sometimes he is naked, at others wrapped in voluminous drapery.

Greek and Roman writers regarded the Greek Kronos and the Roman Saturnus as the same deity. By recent writers their identity has been doubted. Their identity has been maintained with strong arguments by Buttmann, 'Mythologus,' ii. 28, &c.; but as strenuously opposed by Hartung, 'Die Relig. der Röm.' ii. 123, &c., who considers the two divinities as quite distinct, and Saturnus as an ancient national divinity of the Italians. Certain it is that there are few if any points of resemblance between their attributes: the chief coincidence is that each was regarded as the most ancient deity of his country. Both the deities are figured in ancient works of art with a sickle in their hand; but the sickle of Kronos had reference to the harpe given him by his mother Gæa, while that of Saturnus was typical of his protection of husbandry.

Saturnus was one of the principal divinities of the ancient Italians. He was considered to be the protector of agriculture, and of all civilisation arising from it. His name probably contains the same element as the verb *sero* (*sa*), whence he was considered as the protecting divinity of all that was sown and planted, and as the giver of plenty. The Italian legends represented him as having come from abroad to the shores of Italy, in the reign of Janus, by whom he was hospitably received. Notwithstanding this, Saturnus was always considered as the first king of the Aborigines, probably because agriculture and civilisation in Italy dated from his reign. (Virg., 'Aen.,' viii. 319; Aurel. Vict., 'De Orig. Gent. Rom.,' c. 1,' &c.) He was said to have established a settlement on the Capitoline Hill, which from this circumstance was called the Saturnian Hill, and the settlement itself Saturnia. He now began to teach the Italians the art of cultivating the fields, and led them from their savage state to the peaceful occupations of civilised life, so that the whole land of Italy was called, after him, Saturnia, or the land of fruit. In agriculture he is said to have taught his subjects the use of manure (*stercus*), from which he derived the surnames of Stercutus, Stercilinus, and Stercenius. (Macrob., 'Sat.,' i. 7.) His rule was so just and mild, that the age in which he reigned was afterwards described as the golden age of Italy. His wife, called Ops, was in aftertimes worshipped as the goddess of plenty. After the death of Saturnus, or rather after his disappearance from the world, he was raised to the rank of a god, an altar was erected to him on the spot which was afterwards called the Forum, and a temple near the foot of the Capitoline. Concerning his worship at Rome, see SATURNALIA.

KUMISS. [KOUMISS.]

KUTEERA, or KATI'RA, a kind of gum, considered in India by the native practitioners of medicine to be a good substitute for Tragacanth. Indeed, they consider it to be the true Tragacanth, which is described by Avicenna under the name *kuseera* in the original Arabic, while the plant which yields it is named *Ketad*, and its gum *Dragacanthum*. The Kuteera gum a good deal resembles Tragacanth in appearance, but does not in other respects correspond with that gum, according to the experiments which have been made on it in Europe. It has been described by Martius under the name *Kuteera* ('Pharmakognosie,' p. 338), which Guibourt says is the same as his *Gomme de Bassora*; it is intermediate between tragacanth and bassorin —when pure, it is almost entirely bassorin. Like the latter, it swells very much in water, and has a faint vinegar-like odour. Dr. Roxburgh states that *Sterculia urens* "yields a gum not unlike Tragacanth, and has been sent to London as such; but the artists, who use that gum, did not find it answer." He however mentions that the water in which he kept the green branches for examination became thick, like a clear glutinous jelly, while the bark was exceedingly astringent. ('Fl. Ind.,' p. 111.) Dr. Royle, on the contrary, states that the gum called *Kuteera*, and used as a substitute for Tragacanth in north-western India, is yielded by *Cochlospermum Gossypium*, and he possesses some of the same kind of gum collected by Mr. Malcolmson in Central India, accompanied with specimens of the tree which yielded it. This is identically the above-named species, which is so highly ornamental on the lower mountains of India, with its large and rich-coloured yellow flowers. Martius considers that it may be the produce of *Acacia leucophlæa*, Willd. or of a Simaruba, the latter conjecture a very improbable source. This gum is used in dyeing. Mr. Simmonds says that Kuteera and Kutira are two distinct gums; the former from *Sterculia urens*, the latter from *Cochlospermum Gossypium*. (Simmonds' 'Dictionary of Trade Products.')

KYANOL. [ANILINE.]

KYNURENIC ACID. [CYNURENIC ACID. Improperly inserted as CYANURENIC ACID.

L

L is a liquid formed at that part of the palate which is near the teeth. It is therefore allied at once to the adjoining liquids *r* and *n*, and to the palato-dental consonants. The various forms which the letter has assumed may be seen in ALPHABET. The interchanges to which it is liable are as follows:—

1. *L* is interchangeable with *r*. Hence from the Greek or rather Latin *apostolo, epistola,* the French have derived *apostre, apôtre; epistre, epître.* Again, in Latin, while from *rivo*, a stream, *rivali*, living near the same stream, and from *aevo*, age, *aequali*, of the same age, are derived; yet *populo* and *familia* lead to the adjectives *populari, familiari*, belonging to the same people, or the same family. These last words it will be observed already possessed an *l*. In the same way the well-known town on the African coast has been called at different times *Algiers* and *Argel*. The Spanish *coronel* corresponds to our *colonel*. Caralis, in Sardinia, is now Cagliari. Salamanca was called in ancient times Salmantica and Hermandica.

2. *L* with *n*, as *Barcino* (onis), *Barcelona; Ruscino, Roussillon; Bononia, Bologna* or *Boulogne, Nebrissa, Lebrixa; πνευμων* from *πνε,ω* or *πλευμων*, Lat. *pulmo; benus* and *bellus* in Latin, *βεντιστος* and *βελτιστος* in Greek: *λιτρον, nitrum; anima* in Lat., Ital. *alma*.

3. *L* with *d*, as *St. Aegidius, St. Giles; gridiron,* meaning *grill-iron;* and the English title *admiral* is derived from the Spanish *almirante.* But see D, No. 4. L is also interchangeable with *t*. (See T.)

4. *Ll* in the middle of words with *li*. Examples of this are abundant in the French pronunciation of the *l mouillé*. Hence from the French *billards* is derived without much alteration of sound the English *billiards*. It is somewhat strange that the English name *Villiers* and the French *Villars*, which are no doubt of the same origin, should be pronounced so perversely that the first writes an *i* and omits to sound it, and the second gives an *i* to the ear and none to the sight. This change prevails between the Greek and Latin languages, as *φυλλο* and *folio*, a leaf; *αλλο* and *alio*, other; *ʽαλλ* and *sali*, leap. Even in the Greek itself *μᾶλλον* must be a corruption, as analogy would require *μαλα, μαλιον, μαλιστα*. It is probable indeed that the Greeks gave to the double *l* in this word the same sound as the French now do. On any other principle it would be impossible to defend the circumflex accent, which is only placed on syllables terminating in a vowel. It would perhaps not be wrong to write *σκῦλλο* rather than *σκῦλο*, corresponding to the Latin *spolio*, a skin or covering. With these forms may be compared *Mallorca*, pronounced *Mayorca*, the Spanish name for *Majorca*. Lastly, the Portuguese write *lh* with the same sound.

5. *L* disappearing. Not very dissimilar is the Italian interchange of *pl, cl, fl*, with *pi, chi, fi;* as from *pleno*, full, *pieno; plano*, flat or low, *piano; Placentia, Piacenza; clavi*, a key, *chiave; claro*, bright, *chiaro; clamare*, to call, *chiamare;* and *flor*, a flower, *fiore; fluctu*, a wave, *fiotto; Florentia*, once *Fiorenza*, now *Firenze*, the existing name of Florence.

This loss of an *l* after a consonant appears in other languages. The German *fliehen*, to fly, has for its chief element *flug*, corresponding to the Latin *fug*. In the same language *flispern* and *fispern* both mean to whisper; *flittich* and *fittich* both mean a wing; *blinzen* corresponds to the English words *blink* and *wink*. The word *dreifach*, threefold, is derived from *drei* and *flach*. Again the Greek *ὑπνο* and the Latin *somno, sopor*, have *sop* for the radical syllable. In the Gothic *in-suepp-an*, the same root has the form *suep*, but in the German *schlaf*, and in English *sleep*. Lastly, the Latin *claud*, shut, and *clavi*, key (words of the same origin, as is proved by the various forms of *suavi*, sweet), appear in German in the form *schluss*, and in English as *shut* and *key*.

6. L with *u*, particularly after an *a*. *Alfidena*, a town, or *Aufidena; ελεημοσυνη*, pity (used by ecclesiastical writers to signify charitable gifts), Ital. *limosina*, Fr. *aumône*, Eng. *alms;* Lat. *altari*, an altar, Fr. *autel;* Lat. *aliqui-uno*, Ital. *alcuno*, Fr. *aucun;* Lat. *ulna*, Fr. *aune*. The French also contract the pronoun and article *à le, à les*, to *au* and *aux*.

7. Many words beginning with an *l* once had other consonants before the *l*, as in Latin, *loco*, a place, *liti*, a suit, *lato*, broad, were once preceded by *st*—thus, *stloco, stliti, stlato*. This explains how *lato* in Latin is the participle of *toll*. It must once have been *tlato*, corresponding to the Greek forms of the same root, namely, *τλη-τος, τλη-μων*, as well as *τολ-μη*. Again the English *liquorice* is a corruption from the word *glyco-rhiza*, sweet-root. To this head perhaps belongs the Welsh sound of words beginning with *ll*, as for example all the places beginning with *Llan*, which is pronounced by some as *thlan*, by others as *flan*. Perhaps *lana* and *flannel* are kindred words.

8. *L* is very apt to appear in a root, sometimes before a vowel, sometimes after one, as in the Greek words *καλε* or *κλη*, *βαλ* or *βλη*, &c. Where this slipping occurs after a sound like *k*, the *l* is apt to be converted into an *r*. Thus the Greek *σκαλευ*, poke, is in Latin *scru-tari* (compare the phrase *scrutari ignem*, to poke the fire). So *καλυπτω* and *κρυπτω* are of the same origin; *σκελος* and the Latin *crus*, *σκολοψ* and *crux; celeber* and *creber*.

LA, in music, the name given in England, Italy, and France, to the sixth of the syllables used in solmisation [SOLMISATION], and by the two latter countries to the note called A by the Germans and English.

LABORATORY, the room in which chemical operations are performed. The requisites for the proper arrangement of, and the necessary instruments for, a laboratory may be seen at length in Professor Faraday's 'Chemical Manipulation,' or in Williams's 'Handbook of Chemical Manipulation.'

LABOUR. [WAGES.]

LAC, a resinous substance, which in the East Indies flows from certain trees in the state of a milky fluid, on account of the puncture made by a small insect, the *Coccus ficus*, in their branches, in order to deposit its ova. The trees are principally the *Ficus Indica, Ficus religiosa*, and *Rhamnus jujuba*.

There are three kinds of lac known in commerce, and they are distinguished by the names of *stick-lac, seed-lac*, and *shell-lac*. Stick-lac is the substance in its natural state; it is of a reddish colour, and encrusts small twigs; when broken off and boiled in water, it loses its red colour, and is then termed *seed-lac;* and when melted and reduced to the state of thin plates, it is called *shell-lac*, which has a yellowish-brown colour. Mr. Hatchett appears to have been the first chemist who minutely examined these substances, but Dr. John, who has more recently examined stick-lac, gives as its composition—

Resin, insoluble in ether	66·66
Laccin	16·66
Colouring matter	3·75
Extractive	2·50
Cochineal coloured coverings of insects	2·08
Waxy tallow	1·66
Laccic acid	0·62
Yellow extract	0·41
Salts of potash, lime, iron, and earthy matter	1·66
Loss	4·
	100·

Notwithstanding the seeming accuracy of the details of the above-mentioned analysis, it would appear that further experiments are still required to determine the nature of lac; for Unverdorben has, since this analysis was published, stated the results of his examination; 1st, laccin; 2nd, red colouring matter; 3rd, resin soluble in alcohol, but not in ether; 4th, resinous looking matter, slightly soluble in cold alcohol; 5th, crystallisable resin; 6th, uncrystallisable resin, soluble in alcohol and ether, but not in naphtha; 7th, wax; 8th fat of coccus, not saponifiable, and some oleic and margaric acids.

Shell-lac is largely employed in the manufacture of sealing-wax; it answers this purpose better than any other resinous matter, because it melts without charring, and consequently without giving much smoke, and also because it is hard and less brittle than other resins. Shell-lac is also used in varnishes; and is so good an insulator of electricity that a needle made of it is said to remain some days excited.

Laccin.—The properties of the substance to which this name has been given, and which remained after the lac had been repeatedly digested in alcohol and water, are, that it is hard and brittle, of a yellow colour, and slightly transparent. It is insoluble in water, but softens in it when hot; and it also swells and softens, but without dissolving, in alcohol either cold or hot; nor do ether or oils take it up. It is dissolved by concentrated sulphuric acid. Concentrated nitric acid, when heated, dissolves it slowly. Solution of potash dissolves it readily.

Laccic acid separates from solution in water, by spontaneous evaporation, in crystalline grains. It attracts moisture from the air, does not precipitate either the salts of lime or baryta, but throws down those of mercury and lead; the persalts of iron are precipitated white by it. With the alkalies and with lime it forms salts which are soluble in alcohol and in water, and are deliquescent.

The colouring matter of stick-lac is said to be similar to that of cochineal. It is used for the same purposes, and yields a scarlet but little inferior to it.

Lac Dye and *Lac Lake*, two preparations of lac which are manufactured in the East Indies, and used to a very considerable extent in scarlet dyeing: they appear to be prepared by dissolving stick-lac in an alkali, as potash or soda, and then adding a solution of alum; by this there is precipitated a mixture of the alumina of the alum and the resinous and colouring matter of the stick-lac. The lac dye is much the more valuable of the two.

The principal uses to which lac in its various forms is applied are for the making of sealing-wax, for varnishes, for japanning, and for scarlet dyeing. The trade in lac has of late years become of some importance.

LACE MANUFACTURE. All the varieties of lace are easily grouped into two classes, according as they are made by hand or by machine.

Hand or Pillow Lace. This fabric differs essentially in form and appearance from the products of an ordinary loom. Until about three centuries ago, lace was made by the needle on a piece of fine woven material, the threads of which were drawn aside to form holes or meshes, held in position by a few stitches. In 1561 Barbara Uttmann, of Annaberg, devised a mode of twisting threads round pins, so as to form a knotted or netted fabric; this was the real origin of pillow lace, the making of which gradually extended to various European countries.

The implements used by hand-lace-makers are few in number, and inartificial in character. They consist of a pillow or cushion, a series of bobbins or small cylindrical pieces of wood round which the thread or silk employed is wound, and pins which are stuck into the cushion and around which the threads are twisted. The pattern of the lace is determined by the disposition of the pins; and this is regulated by holes pierced in a piece of parchment which is laid upon the cushion. It is not possible to give in writing an intelligible description of the processes of lace-making by means of these implements; but it will be understood that the effect is produced by the twisting together of the threads upon the bobbins, and their being woven among and around the pins. The pattern depends partly upon the order of arrangement preserved in these twistings and weavings, and partly upon the introduction of a thicker thread, called *gymp*, which is used for the formation of figures, flowers, and other ornaments.

The finest pillow-lace is made on the continent. It is known in most cases by the names of the towns in which the fabrication is chiefly carried on. The most valuable is *Brussels*, of which there are two kinds, *Brussels-ground* and *Wire-ground*. Brussels-ground has a hexagon mesh, formed by plaiting and twisting four threads of flax to a perpendicular thread; whereas Wire-ground consists of silk, the meshes partly straight and partly arched, and the pattern, worked separately, being set on by a needle. *Mechlin lace* has a hexagon mesh formed of three flax threads twisted and plaited to a perpendicular thread; the pattern being worked in the net. *Valenciennes lace* has an irregular hexagon mesh, formed of two threads partly twisted and plaited at the top of the mesh; the pattern is worked on the net. *Lisle lace* has a diamond-shaped mesh, formed of two threads plaited to a perpendicular. *Alençon blond* has a hexagon mesh of two threads; it is one of the poorest of pillow-laces. *Alençon point* has two threads twisted round a perpendicular, with octagon and square meshes alternately.

The best Brussels lace excels all others in delicate fineness, and in elegance and variety of design. It is made of flax grown near Hal and at Rebecque; and the spinning is performed in darkened rooms, with a beam of light admitted only upon the work through a small aperture. The best specimens are produced by the firms of Tardent-Poilet, and Ducpetiaux, of Brussels. In former days, when Mechlin and Brussels lace often descended as heir-looms from mothers to daughters, the manufacture was confined to lace from the finest thread that could be prepared from flax; and neither time nor expense was spared in that preparation. There is now, however, a great deal of cotton worked up in the Belgian lace of medium and inferior quality. In 1856–7–8, Belgium exported nearly as much cotton lace as flax and silk lace, about a value of 100,000*l.* of each, chiefly to France. This cotton-lace, however, is mostly of the character of machine-made bobbin-net; for real pillow-lace is seldom made of other materials than flax or silk.

Besides the description above given, of the different numbers of threads and forms of mesh, the kinds of foreign lace present other diversities, which are being influenced a good deal at the present day by the machine-made net of Nottingham. Formerly the ground for Brussels lace was made in strips from one to three inches wide, which were afterwards joined with such admirable ingenuity as to render the line of junction imperceptible. But the slowness of the process rendered the product very costly; trimming-lace of four inches in width often brought ten guineas a yard, and veils were from twenty to a hundred guineas each. Now, however, the beautiful net made by machine at Nottingham is more and more used as a ground in Belgium; the flowers or designs being made on the pillow, and afterwards attached to the ground by the needle. This *appliqué* lace is now largely made, and is gradually superseding the real Brussels point—insomuch that the old specimens are acquiring the antiquarian value which connoisseurs attach to old pictures and old china, depending quite as much on the rarity as on the excellence. Mechlin lace is all made in one piece, without joining; and its peculiarity consists in a plait-thread surrounding the flowers, so as to give the appearance of embroidery. Valenciennes lace, since about 1835, has been more largely made at Ypres than at the town whose name it bears; the dealers now purchase the handiwork of at least 20,000 persons in and around Ypres. In France it is supposed that 200,000 females are employed in pillow-lace making, earning on an average about a penny an hour. Not only flax and silk, but cotton, wool, and gold and silver thread, are often worked up by them into lace; cotton is increasing in use, relatively to flax. Caen and Bayeux excel in silk-lace piece goods, such as veils, scarfs, berthes, mantles, robes, and shawls; Chantilly in the more elaborate and costly kinds of silk-lace; Mirecourt in the elegance of designs for very light and open lace in flax-thread; Alençon in the costly fineness of the flax-thread used for making the Alençon point; and Puy in the cheapness of the lace made by 40,000 or 50,000 workers scattered in the neighbouring departments.

In England, pillow-lace making is supposed to have been introduced by some refugees from Flanders, about 1626, in or near Buckinghamshire; and for a long time that county maintained a fair rivalry with France and Flanders. In the counties of Buckingham and Bedford the cottagers are largely employed in this branch of industry. In 1800 the number so employed was estimated at 130,000; but the Nottingham machine-lace has since proved a formidable competitor. The kind called *Honiton-lace* is made by placing a perforated pattern upon a pillow, and working the thread round pins in the same way as other pillow-lace; but the difference is this, that Honiton-lace only consists of flowers and devices, which are afterwards sewn on to net made either by hand or by machine. Seven or eight thousand women and girls are employed in the south-eastern part of Devonshire making Honiton-lace; and as much as two hundred guineas has been given for a dress of this material. In the Midland counties the pillow-lace makers have had an increased demand for black-lace, thereby in part compensating them for the loss occassioned in other ways. *British point*, made near London, is an imitation of Brussels and Honiton-lace. *Limerick-lace* is somewhat similar in character. This branch of industry was founded in 1829, by Mr. Charles Walker, who settled at Limerick, leased a large building, took over with him several lace-workers from England, and taught the art to Irish peasant girls; the pupils were quick in learning and clever in manipulation, and a manufacture has been established, which has greatly benefited the town and neighbourhood. There are now many firms engaged in the trade, one of which employs 500 or 600 hands; the earnings vary from 3*s.* to 8*s.* per week. *Tambour-lace*, made at Coggeshall and other places, is a sort of medium between lace and embroidery.

Machine-lace or Net.—The production of light cross-woven goods, previous to the extraordinary development of the bobbin-net manufacture at Nottingham, was carried on only to a limited extent. *Net* was the generic name for these goods; and according as slight deviations were made in the mode of crossing the threads, so were distinctive names given to the material produced; such as whip-net, mail-net, patent-net, drop-net, spider-net, Paris-net, balloon-net, &c. All these varieties were produced at the loom, with warp-threads stretched horizontally, and weft-threads thrown across by means of a shuttle; and the difference between them depended on the manner in which the warp-threads were made to cross one another, and in which the weft-thread was thrown.

In 1758 Mr. Strutt's machine for Derby-rib hosiery, or lace-work ankles and insteps to stockings, was the first approach towards a machine for lace-making. Morris's eyelet-hole machine, in 1763, by which open-work mitts and gloves were made, was a still nearer approach. Crane's Vandyck stocking-web machine, in 1768, produced flowered and spider nets; and Else and Harvey's pin machine, about the same time, was the foundation for the machines ever since used in France and Austria for making tulle and other kinds of silk net. Frost's point machine, in 1777, consisted of a fine gauze stocking frame which, by a few delicate changes, was made to produce a perfect web of lace, in hexagonal looped meshes—all weft, without any warp threads. This was soon superseded by another which manufactured what was termed *point-net*, invented by Lindley, and afterwards improved by Taylor and Flint. The point-net became so highly approved, that there were no fewer than a thousand machines at work at the beginning of the present century. Next succeeded Dawson's warp-machine, which produced *warp-net* in successful competition with the *point-net*; there was warp as well as weft, and the fabric was made to serve both for hosiery and for lace. Still however the net produced did not afford a good imitation of the bobbin-lace or pillow-lace; and the Nottingham manufacturers threw out every inducement for the development of a machine which should produce such an imitation. At length, in 1809, Mr. John Heathcoat, a stocking-weaver of Loughborough, availing himself of an ingenious principle involved in a machine for making fishing-nets, invented a few years before by Robert Brown, of Nottingham, produced and patented the *bobbin-net* machine, one of the triumphs of modern ingenuity. From this time a new field of industry became opened, into which capital and skill rapidly entered. The traverse-warp machine of Brown, the straight-bolt machine of Morley, the pusher-machine of Mart and Clark, the circular-bolt machine of Morley, and the lever-machine of Leavers, were successive improvements on Heathcoat's bobbin-net machine, involving its main principle, but working it out more effectually. In all of these the warp is beamed. At first it required fifty movements to make one mesh; these have now been reduced to six. No less than 40,000 meshes can be made in a minute.

The main points of difference between the bobbin-net machine and the common loom may be thus stated. In the former the warp-threads are vertical; in the latter they are horizontal. In the former the weft is wound on a brass bobbin so thin as to pass between the adjacent threads of the warp; in the latter it is contained in a shuttle an inch or more in width. In the former the transit of the weft-thread, while passing between the warp, is at right angles to the plane of the web; in the latter it is parallel with that plane. In the former the successive meshes or intersections are driven up close to those before made, by a series of pointed wires catching in the loops; in the latter they are driven up by the lay or batten. In the former there are sometimes as many as three thousand bobbins or weft-carrying implements to one machine; in the latter there are seldom more than one or two shuttles. In the former each bobbin twists its weft-thread round a warp-thread by a series of oscillatory movements like those of a pendulum; in the latter the twisting is effected rather by the movements of the warp than those of the weft. What is the kind of work which these machines have to perform will be seen by the annexed cuts; in which *fig.* 1 shows roughly how threads may be twisted to form meshes; while *figs.* 2 and 3 show two kinds as actually produced.

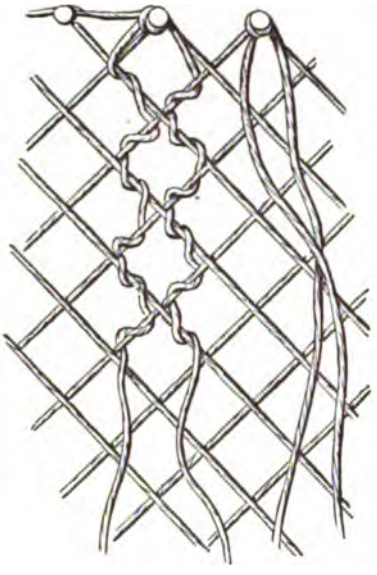


Fig. 1.—Threads twisted into Meshes.

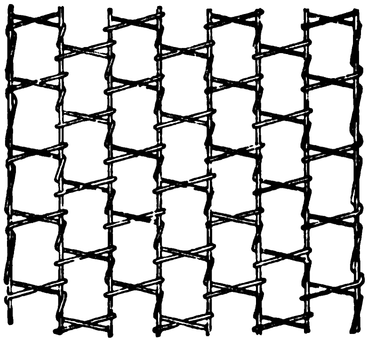


Fig. 2.—Rectangular Meshes.

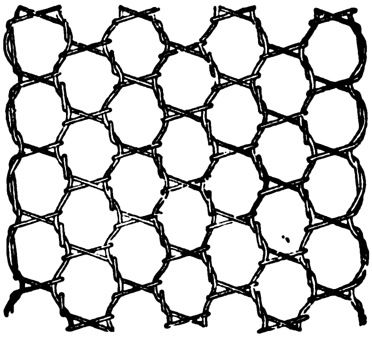


Fig. 3.—Hexagonal Meshes.

Fig. 4 shows the essential parts of the bobbin-net machine, affording some notion of its extreme complexity of action.

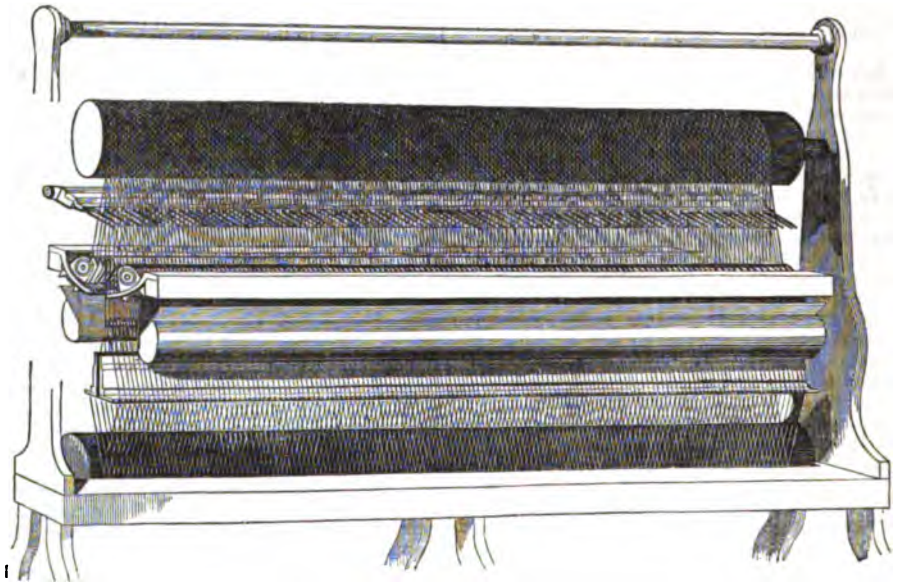


Fig. 4.—Essential Parts of Bobbin-net Machine.

The activity to which the invention of the bobbin-net machine gave rise was quite extraordinary, and the profits accruing to the various inventors were at first very large. The productions of the machine superseded the older fabrics by the extraordinary cheapness at which they were made; so that bobbin-net, resembling that for which, in 1809, five guineas a yard were given, is furnished in 1860 for sixpence. [Cotton Manufacture.]

From certain statistical details which Mr. Felkin, of Nottingham, the leading authority on this subject, furnished to the Factory Commissioners about the year 1833, it appears that at that time the quantity of cotton used annually in England for bobbin-net was about 2,387,000 lbs., value about 200,000*l.*; that this was made into thirty million yards of net, value nearly two millions sterling; that 160,000 persons were employed in spinning, doubling, weaving, mending, pearling, finishing, and embroidering the net; that the fixed and floating capital invested in the bobbin-net manufacture reached as high as two millions sterling; and that there were from four to five thousand bobbin-net machines then in England. Some of these machines produced net twenty quarters or five yards in width. Many of them now have as many as 4500 cards with the Jacquard apparatus [Jacquard Apparatus]; and it may with truth be said, that such a machine, with its three or four thousand delicately-constructed brass bobbins, and provided with a Jacquard apparatus, is one of the most exquisite pieces of mechanism which our manufacturers can exhibit.

The hand-workers of the Midland Counties rose in violence against Mr. Heathcoat and his machines; and he went to live at Tiverton, in Devonshire, to be free from interruption. Tiverton, with off-shoots at Barnstaple and Chard, has become the head-quarters for a particular kind of machine-made silk-net; while machines on Heathcoat's principle have borne down all opposition at Nottingham and elsewhere. They did not, however, drive out the warp machines, which are found to be suitable for a particular class of goods,—blond, edging, net, and lace of silk: tattings, pearl trimmings, net, and lace, of cotton; D'Oyleys, anti-macassars, and other articles of a cheap and durable kind. Mr. Felkin, in 1843, estimated that there were at that time 300 of these machines at work upon silk, 500 upon cotton, 5000 hands employed, and 850,000*l.* worth of goods annually produced, of which 290,000*l.* was available as wages, interest, and profit.

In a later estimate, in relation to the whole trade, Mr. Felkin stated that in 1856 there were 3500 machines making net, many as much as five yards in width, and all averaging three yards. More than half were engaged on fancy net or lace; and of the other half 1300 were rotary circular machines, making plain goods. Many fine large factories had been built at Nottingham since 1850, to work these machines. The returns he set down at about 3,000,000*l.* annually, of which 2,200,000*l.* was divided among the masters and workmen for interest, profit, and wages, leaving the rest for the purchase of raw material. There were 115 wholesale firms in Nottingham alone, engaged in this trade. The cotton-yarn used for net varies from No. 20 to No. 400, the latter of which is so fine that 100 miles of it would barely weigh a pound. We may remark that *quilling*, *tatting*, and *pearl*-lace or net are all made in narrow strips.

In the processes of 'lace-running' and 'tambouring,' largely carried on in and near Nottingham, the operation approaches more nearly to a kind of weaving; for the bobbin-net, which forms the ground, is stretched horizontally on a frame, and the lace-runner works a series of ornaments in the net by a needle threaded with coarse cotton, the pattern being previously marked on the net. In the process of 'tambouring' net, the cotton thread is carried to and fro between the meshes of the net by means of a very fine and small hook, which gives to the decorative figure thus produced much more the appearance of chain-work than the instance above noticed. *Figs.* 5 and 6 show the difference between machine-lace and run-lace—that in which the device is worked by the machine, and that wherein the device is wrought by a needle on plain net.

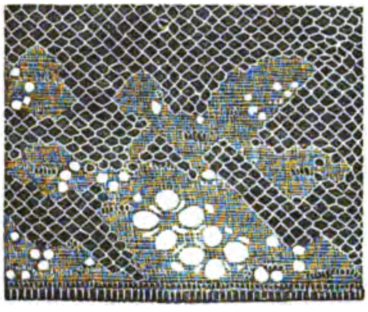


Fig. 5.—Machine Lace.

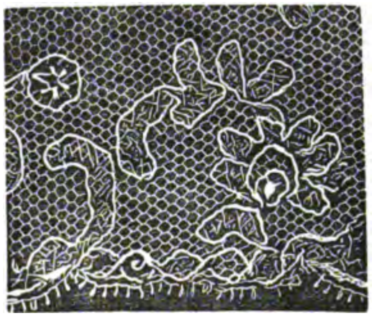


Fig. 6.—Run Lace.

Lace-making and net-making machines have been introduced into France and Belgium, mostly from England; but Nottingham still continues to be the head-quarters of the trade.

LACERTA (the Lizard), a constellation of Hevelius, surrounded by Andromeda, Cepheus, Cygnus, and Pegasus. The following are the principal stars in this constellation.

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
α	1	7855	4
β	3	7815	4

LACHRYMAL ORGANS, DISEASES OF THE. The lachrymal gland is very rarely the seat of disease. It sometimes suppurates from acute inflammation, but it is more commonly affected with a chronic enlargement and induration, forming a prominent tumour under the upper eyelid, which pushes the eye downwards and inwards. In this state it may be removed without difficulty and with perfect safety from beneath the eyelid.

The most frequent disease of these organs is that commonly called fistula lachrymalis, which consists of inflammation of the lachrymal sac. [Eye, Nat. Hist. Div.] When the inflammation is acute, it forms a tumour of about the size and shape of a horse-bean at the inner side of the eye, which is firm, red, hot, and extremely painful. The nasal duct being closed, the tears, which should pass through it into the nose, flow continually over the cheek, and produce redness and excoriation. The eyelids swell, and the pain and tension are sometimes so severe as to excite considerable fever and even delirium. If the inflammation be not early checked, suppuration takes place, and the matter may escape by an opening, which sometimes remains for a long time fistulous, at the corner of the eye. The treatment must be actively reducing, and when suppuration has taken place an early opening should be made into the sac at its most prominent part.

In the chronic inflammation of the lachrymal sac, which often succeeds to the acute, the nasal duct continuing obstructed, the sac becomes frequently distended with its secretion, and a mixture of mucous and purulent matter may be pressed out of it through the puncta lachrymalia. In some cases no other inconvenience is produced than that of the necessity of pressing out the contents of the sac once or twice a day; but in others, attacks of acute inflammation are apt to supervene, and excite very painful affections both of the lachrymal apparatus and the eye itself. In the first instance, leeches and other antiphlogistic remedies should be employed; but if they are unsuccessful, astringent lotions should be applied to the eye, that they may be imbibed by the puncta lachrymalia, and conveyed through them to the nasal duct. But if these means fail, the lachrymal sac must be punctured near the inner angle of the eye, and a probe passed through it into the nose. A portion of bougie must be introduced into the passage thus restored; the canal will enlarge around it so as to permit the tears to pass through, and after a few days the bougie may be exchanged for a nail-headed style, which must be worn in the canal and sac for a considerable time.

LACHRYMATORY, a small earthen or glass vessel, generally with a long neck, found in the sepulchres of the ancients. Chifflet, in his 'Lachrymæ prisco ritu diffusæ,' first started the idea that they were intended to hold the tears of relatives or friends, who assisted at the funeral rites; and the notion was long supported by the antiquaries of different countries throughout Europe. It was afterwards combated by Schœpflin and Paciaudi, and as no such use of these phials or little bottles can be discovered in passages of the Roman writers, the conclusion was at length come to that they were intended to contain perfumes or balms only for sprinkling upon the funeral pile.

LACQUERING. [Japanning; Varnish.]

LACTAMIC ACID. [Lactic Acid.]

LACTAMIDE. [Lactic Acid.]

LACTIC ACID (from *lacte*, milk) ($C_{12}H_{12}O_{12}$) is the substance that gives the well known acidity to sour milk. It is produced from the milk-sugar by the fermentive action of the casein or cheese portion. This acid is also met with in many other processes where starches or sugars other than milk-sugar are undergoing fermentation. It occurs in the fluids of the muscular tissue. When required in quantity lactic acid is most conveniently prepared by adding one part of common cheese to a solution of eight parts of milk-sugar in about fifty of water, stirring in three parts of powdered chalk and setting the whole aside for two or three weeks in a warm place (80° Fahr.). The mixture slowly becomes filled with crystals of lactate of lime, these are separated by straining, purified by re-crystallisation from water, decomposed with about one-third of their weight of sulphuric acid, and the liquor, freed from the sulphate of lime by filtration, is decolorised by treatment with animal charcoal, and concentrated by evaporation.

Lactic acid is uncrystallisable. When pure it has the consistence of strong syrup, is transparent, colourless, inodorous, of intensely acid taste, and has a specific gravity of 1·21. Exposed to the air it absorbs water, in which it is soluble in all proportions. It is also very soluble in alcohol and ether. An exceedingly minute quantity of it at once causes the coagulation of boiling milk. Nitric acid converts it into oxalic acid. By careful application of heat to lactic acid, contained in vessels from which air is excluded, it may be distilled; but at a temperature of 500° Fahr. is converted into carbonic acid, aldehyd, citraconic acid, *lactide* ($C_{12}H_8O_8$), and *lactone* ($C_{10}H_8O_4$). By the continued action of a heat of about 266° Fahr. lactic acid is gradually converted into *lactic anhydride* ($C_{12}H_{10}O_{10}$), a fusible, bitter substance of yellow colour, insoluble in water, but gradually re-converted by prolonged contact with that liquid into lactic acid.

Lactone ($C_{10}H_8O_4$) is a pungent volatile liquid. Boiling point 198° Fahr.

Lactide ($C_{12}H_8O_8$), obtained in the manner just described, crystallises from alcohol in clear white rhomboidal tables. It may be sublimed without undergoing decomposition. Water gradually converts it into lactic acid, and ammonia forms with it lactamide.

$$\underbrace{C_{12}H_8O_8}_{\text{Lactide.}} + \underbrace{2NH_3}_{\text{Ammonia.}} = \underbrace{C_{12}H_{14}N_2O_8}_{\text{Lactamide.}}$$

Lactamide ($C_{12}H_{14}N_2O_8$) is also obtained by the action of lactic acid on ammonia. It is interesting as being identical in composition with three other bodies, alanine, sarcosine, and urethane (carbamate of the oxide of ethyl). They have all of them, however, very distinct properties. This substance differs from the others in yielding lactic acid and ammonia when acted on by acids and bases; hence its name. It is very soluble in alcohol and water, and crystallises in plates or prisms.

Lactamic acid, in combination with ammonia, results from the action of the dry gas upon lactic anhydride. The salt contains ($C_{12}H_{12}(NH_4)NO_{10}$).

Metallic derivatives of lactic acid. One or two equivalents of the hydrogen in lactic acid may be replaced by one or two equivalents of metal forming respectively acid and neutral salts; the latter are more stable than the former. The salts of the alkalies do not crystallise; those of baryta and lime with difficulty; that of zinc (neutral) in four-sided prisms.

The true *constitution of lactic acid* is not yet clearly determined. Wurtz has recently succeeded in obtaining a *lactic ether* which may be said to contain four equivalents of ethyl in the place of an equal number of hydrogen in lactic acid. Wurtz, however, considers that lactic acid is the alcohol of a biatomic radical *lactyl* ($C_6H_4O_2$), and is thus formulated:

$$\left.\begin{matrix} C_6H_4O_2'' \\ HH \end{matrix}\right\} O_4.$$

In addition to lactic ether just mentioned, Wurtz has obtained lactobutyric ether by the re-action of *chlorolactic ether* ($C_6H_4O_2''$, C_4H_5, Cl, O_2) on butyrate of potash. The following are his formulæ for these two ethers:—

$$\underbrace{\left.\begin{matrix} C_6H_4O_2'' \\ C_4H_5,\ C_4H_5 \end{matrix}\right\} O_4}_{\text{Lactic ether.}} \qquad \underbrace{\left.\begin{matrix} C_6H_4O_2'' \\ C_8H_7O_2,\ C_4H_5 \end{matrix}\right\} O_4}_{\text{Lactobutyric ether.}}$$

Corresponding metallic derivatives are said to have been produced but not without difficulty in the case of the second atom of hydrogen in the lactic acid as represented by Wurtz. Those containing one atom only of hydrogen replaced correspond to the salts already mentioned under the name of neutral salts of lactic acid; while the acid salts described at the same place would, under Wurtz's view, somewhat resemble quadroxalates, and be derived from a double equivalent of his lactic acid by substitution of an atom of metal for one of hydrogen.

LACTIC ETHER. [LACTIC ACID; ETHEREAL SALTS.]

LACTIDE. [LACTIC ACID.]

LACTIN. [SUGAR; *Sugar of Milk.*]

LACTOBUTYRIC ETHER. [LACTIC ACID.]

LACTONE. [LACTIC ACID.]

LACTOSE. [SUGAR; *Sugar of Milk.*]

LACTUCARIUM, the medical uses of, are sufficiently described under this head in the NAT. HIST. DIV.

LACTUCINE is the active principle of the *Lactuca virosa,* or wild lettuce. It is obtained from the juice of this plant, which is called Lactucarium. It is a bitter, crystalline, resinoid substance, possessing anodyne properties.

LACTUCONE ($C_{30}H_{64}O_6$). A crystallisable principle contained in the juice of the wild lettuce (*Lactuca virosa*). It is insoluble in water, but very soluble in alcohol and ether. It possesses neither acid nor alkaline properties.

LACTYL. [LACTIC ACID.]

LADANUM. ($C_{40}H_{30}O_6$). A resinous body which exudes from the shrub *Cistisus creticus.* It is a black tenacious solid which softens between the fingers and diffuses an odour resembling ambergris.

LADDER, the portion of a scaffolding by means of which workmen are enabled to pass from one level to another; and any steep staircases, with extremely narrow treads, such as are used in mines, factories, or warehouses, or even in ships' holds, are known by the name of ladders. The principal distinction between ladders and staircases appears to consist mainly in this—namely, that with staircases there is no necessity for using the hands whilst mounting or descending, whereas with ladders it would not be possible to maintain a footing without at the same time holding either the sides, or the rounds, with the hand. The parts of a ladder are, simply, *the sides,* which are usually made of round fir-poles cut down the middle (and in England used with the convex sides outwards, whilst on the Continent the flat transverse sections are placed outwards); *the rounds,* usually made of oak, of a circular section, rather larger in diameter in the middle and tapering towards the sides, and fastened to the said sides by fox-wedges; and occasionally iron cross-ties are inserted, in order to resist any tendency on the part of the sides to spread. The distance apart of the rounds varies from nine inches to one foot, but ten inches is the distance most generally adopted, for scaffolding at least.

There are some modifications of ladders used in particular trades, such as the plasterers' or painters' ladders, made out of wrought and squared stuff, and with hinges at the top; and upholsterers' step-ladders, which have hinged flaps at the backs and flat treads. Millers' ladders have flat treads, and sometimes handrails on the outside; but they, and the companion ladders of ships, ought more correctly to be classed as staircases. The chain of buckets of a dredging-machine is also at times called a "ladder."

In the cathedral of Nürenberg the idea of the ladder has been admirably converted into an architectural decoration in the details of the canopy of the pulpit; and it may indeed be observed, that story of the ladder perceived by Jacob in his dream is one which would have very probably suggested its introduction into ecclesiastical decoration. The designer and sculptor of the Nürenberg pulpit was Adam Kraft, who flourished about the end of the 15th century.

LADING, BILL OF. [BILL OF LADING.]

LÆVORACEMIC ACID. [TARTARIC ACID.]

LÆVOTARTARIC ACID. [TARTARIC ACID.]

LAGOON, or LAGUNE. Lagoons are sheets of water formed either by the encroachments of rivers or seas upon the land, or by the separation of a portion of the sea by the intervention of a bank. Thus there are fluvial and marine lagoons. When the land on either side of a river's course is lower than the immediate banks of the stream, and the river, in the season of the floods, either overflows its banks or in part breaks them down, the water inundates the low land; and if on the subsidence of the flood the water again flows back into the channel, the lagoon is merely temporary, and is simply an inundation. This, according to circumstances, may be a benefit to the country or a disaster. Inundations are a benefit when they bring with them and deposit a rich vegetable humus, which, on being cultivated, yields abundant crops; to such deposits Lower Egypt owes its great fertility Inundations of this kind either diminish or increase annually, for, by repeated deposits, the soil becomes raised; and unless the bed of the river rise in proportion, the water is eventually kept within its channel; but if, on the contrary, the bed rise, the inundation gains every year in extent of surface what it loses in depth of water. Should the inundation however, instead of a prolific mud, bring nothing but sand and stones, then, as has been frequently experienced in Italy, the inundations are a cruel disaster, for they condemn rich lands to eternal barrenness and sterility. If the configuration of the land and other circumstances prevent the water of the inundated parts from flowing back on the subsidence of the flood, then a permanent lagoon is formed, and the land thus laid under water can only be recovered at a great expense, even if that be possible. These lagoons are generally fatal to the neighbourhood, for the water in them, being stagnant, gives rise to unwholesome miasmata, producing agues and other malignant disorders. Such lagoons are not absolutely confined to the lower parts of water-courses, though it is in such places that they are most frequently met with. Fluvial lagoons are sometimes formed by infiltration; a remarkable instance of which is the marshy lagoon of Ybera, on the Parana, in South America.

Marine lagoons are much more common than those on the borders of rivers. They are formed sometimes by the encroachments of the sea, and sometimes by the throwing up of a bar or bank, which eventually divides off a portion of the sea altogether, or leaves merely a small opening. In Europe there are many marine lagoons; the Adriatic, on its north and north-western parts particularly, is full of them. The Zuyder Zee is a vast lagoon. There are also two very large ones known by the names of the Frische Haff and the Curische Haff, at the south-east angle of the Baltic Sea. In the Sea of Azoff there is the Sivasch or Putrid Sea. On the east coast of South America there are some very large lagoons, and they abound at the bottom of the Mexican Gulf. Marine lagoons can never be useful unless when sufficiently large and deep to admit of being navigated, in which case they form secure harbours. When shallow, they give out fœtid exhalations like fluvial lagoons, as is too well known in Venice, which is built on the 60 islands of the lagoon at the extremity of the gulf; though in this case much of the evil arises undoubtedly from the circumstance of the lagoon being the receptacle of all the filth of the city.

LAITY, persons not clergy; that is, the whole population except those who are in holy orders. All the lexicographers, we believe, agree in deriving it from the Greek word *laos* (λαός), the people. A *layman* is one of the laity. The terms are not used except when the mind is directed to the distinction of the two classes.

LAKES. [COLOURING MATTERS.]

LAKES are in the land what islands are in the sea; they are surrounded on all sides by land, as islands are by water. They are sheets of water of greater or less extent, and differ from lagoons in their origin, and from tanks and reservoirs by their being naturally formed, whereas the latter are the works of man. From ponds and pools it is not so easy to distinguish them, it being difficult to draw the line between a large pond and a small lake. The feature by which perhaps they would be best distinguished is this, that a lake is fed by streams either flowing at the surface of the soil or subterraneous, while a pond, though large, is only the accumulation of rain-water in some hollow. Thus ponds are usually dried up in hot weather, while true lakes are only temporarily diminished by heat.

Lakes have sometimes been divided into fresh-water lakes and salt-water lakes; though here again it is not easy to draw the line between the two, as from the freshest to the most salt the degrees of saltness are very various.

The principal difference in lakes is this: some have no apparent affluents nor outlet, others have affluents without any visible outlet, some have an outlet without any visible affluents, and others again have both affluents and an outlet. Lakes without outlets have the level of their waters horizontal, that is, parallel to the curvature of the earth; while those with affluents and outfalls are on the contrary more or less out of the horizontal level, sometimes, as in the Lago Maggiore, as much as three inches in a mile.

Lakes without apparent affluents or outlets are comparatively small, and yet they are, relatively speaking, more permanent than larger lakes, because, being fed chiefly by subterraneous springs, they are not liable to be filled by those deposits of earth and sand which are the main cause of the rapid desiccation of such lakes as receive the troubled waters of torrents and rivers. If we follow the usual custom and call all natural sheets of water lakes, then there are many lakes without affluents or outlet. Thus they are very numerous to the northward of the Caspian and in the plains which extend between the Ural Mountains and the Irtish, as also in the great Steppe of Baraba between the Irtish and the Ob. But in truth the greater part of these are more properly ponds, formed of the accumulated waters from rain and melted snow. The largest of them are not more than ten or twelve miles in circumference and six or seven feet deep; indeed many of them are quite dried up towards the end of summer. Some are salt and yield considerable profit. Their saltness is not easily accounted for; the more particularly as among and close to those that are salt there are many whose waters are quite fresh. The opinions of naturalists on the subject of salt lakes are very various, and no satisfactory theory has perhaps yet been offered. Small lakes of the kind of which we have been speaking, that is to say, such as have neither affluents nor outlet, sometimes occur in hollows resembling the craters of extinct volcanoes. There has been much controversy as to the existence of lakes in volcanic rocks. Dolomieu, Spallanzani, and others, asserted their existence, while M. Desmarest absolutely denies the possibility of lakes existing in the craters of extinct volcanoes. But near the present active volcano of Antuco (in the state of La Plata, not far from Mendoza), there is a lake of immense depth, at a height of from 4000 to 5000 feet above the sea, which has such an intimate relation with the volcano, that on every eruption the lake pours out a stream of muddy water, wasting the adjacent district. The little lake of Nemi, about 20 miles from Rome, is unquestionably formed in an old volcanic crater, and that it has increased since its first formation, is shown by its having engulphed a building of the time of Tiberius. The celebrated lake of Averno is, according to Ferber and Breislak, situated in an ancient crater; as were those probably of Bolsena and Bracciano. The subject of lakes, considered geologically, has not yet received the attention it deserves. The connection of lakes with the main ocean is an important but little known question. They are all basins enclosed by certain obstructions that act as dams, and which certain phenomena, such as earthquakes or volcanoes, may destroy, and allow the water to run off. London, there is every reason to suppose, stands on the site of what was once a lake of large size.

Of lakes which receive affluents without having any visible outlet, the largest is the Caspian. The Aral, and the Dead Sea, or Lake Asphaltites, are also examples of this kind of lake, which is very common in Asia. Some of them are of vast extent, such for instance is the lake Terkiri in Tibet, 27 leagues long and 9 leagues wide, and the lake Hoho-nor, or Koko-nor, in the same country, whose surface is 240 square leagues. It was at one time thought that the saltness of certain lakes was due to the circumstance of their receiving the saline impurities of their affluents, which impurities could not escape for want of an outlet; but on the one hand, the Durrah in Segistan, which receives the Helmund and has no outlet, is perfectly fresh; and on the other, there are many salt lakes which have no affluents, hence the saltness of lakes must have some other cause. The question has sometimes been asked, what becomes of the excess of water brought into lakes having no outlet? Halley thought evaporation was all-sufficient to carry it off, and his opinion is highly plausible. If, however, it shall be found by actual experiment that a greater quantity of water is brought into a lake without apparent issue than can be carried off by evaporation, the natural conclusion will be, that the surplus is lost by infiltration or sub-aqueous drainage. Several of these lakes have formerly had outlets, but water has ceased to flow from them, because the lakes have sunk in consequence of receiving now a much smaller quantity of water than formerly. There are many lakes in Europe at the present day whose outlets are diminishing; such among others are the lakes Balaton and Neusiedel in Hungary. The extent of surface of the former is very great compared with the quantity of water which it receives, so that the evaporation is rapidly diminishing the lake, and the river Schio, which used to carry off its superabundant waters and pour them into the Danube, is now nothing more than a slip of bog; and as for the lake Neusiedel, it appears formerly to have communicated with the Danube by the Raab, into which it emptied its waters, and with which it has now no other communication than by a swamp. The Aral also, it is generally believed, once communicated with the Caspian.

Those lakes which have an outlet without any apparent affluent are fed by subaqueous springs, which, bursting out in a hollow, must fill it up before the waters can flow off in a stream. These lakes are generally situated at considerable elevations above the level of the sea. Thus there is one on Monte Rotondo in Corsica, at an elevation of 9069 feet. From lakes of this kind some of the largest rivers take their rise; the Volga, for instance, springs from such a lake in the government of Tver in Russia. The lake Titicaca in the Bolivian Andes, is 12,000 feet above the sea-level, and is 120 fathoms deep, while the Caspian is below the sea-level, according to some, 100 feet. The surface of Lake Superior is 600 feet above the sea-level, and in certain places the lake has a depth of 1200 feet; while not only this but all the other Canadian lakes show evident marks of their level having been originally considerably higher, and that they have been lowered by degrees. Lake Erie has a medium depth of only 60 to 70 feet, and the shallowness there is little doubt is owing to the detritus brought down from the lakes above, and there deposited.

Lakes which receive one or more tributary streams and have a visible outlet for their superabundant waters are the most common and the largest; such are the lakes of Switzerland and of the north of Italy, the lakes Ladoga, Onega, Peipus, and Ilmen in Russia; the Saïma in Finland, the Wener in Sweden, the Enara in Lapland, &c. In Asia there are the Nor-Zaïssan and the Baïkal, &c. In Africa the existence of large lakes in the interior has been well established; first, by the precise verification of lake Tchad, whose outfall is the Niger; and more lately by the discoveries of Dr. Livingstone of the Ngami, of which the great outfall is the Zambezi; by Captain Speke of the lake Nyassi, or Nyanza, which is considered by him as the true source of the Nile. In North America, Lake Superior, Lake Huron, Lake Erie, and Lake Ontario are examples of this kind of lake; each of them receives several affluents; and the grand outlet of the whole is the river St. Lawrence.

Lakes owe their origin to different circumstances: some from the sinking of the soil by the falling in of subterraneous caverns—such is the supposed origin of the Baïkal; others are caused by earthquakes—such a lake was formed in the province of Quito in 1797; some by the fall of mountains, as the Oschenen-see in the canton of Berne; or by lava currents damming up the stream, as the lakes Aidat and Cassiere in Auvergne, in France. Many are supposed to be the remains of the universal ocean which once covered the earth, and their waters originally salt, have become fresh from their receiving constant supplies of fresh water while the salt was continually let off by their outlets.

Almost all lakes are in progress of diminution, although this is not everywhere apparent. The detrital matter brought in by their affluents is imperceptibly filling up their beds; and if regular observations were made, many provinces which owe much of their prosperity to their lakes, would find the time fast approaching when these pieces of water will become mere pestilential marshes.

Certain lakes exhibit remarkable phenomena: thus some have floating islands in them, as is the case with a small lake near St. Omer. The lake Gerdau, in Prussia, has a floating island, on which a hundred head of cattle may be seen pasturing. In the lake Kolk, in Osnabrück, there is a floating island, on which fine elms are growing. Some of these floating islands sink and rise again; thus in the lake Rålang in Smoland, a province of Sweden, there is a floating island which appeared and disappeared ten successive times between the years 1696 and 1766. Other floating islands are found in East Gothland and many other places. Some subterranean lakes are supposed to have become so by the formation and subsequent fixing of floating islands, which successively uniting have finished by forming a solid crust over the water.

Some lakes have a double bottom, which rising and sinking alternately changes the apparent depth of the lake; there is a lake of this kind at Jemtia in Sweden.

Some lakes are said to have no bottom; but this is an impossibility: the fact is, that the sound does not reach the bottom, either for want of sufficient weight of lead or length of line, or else it is carried away by under-currents.

In Poland there exists a lake said to render brown the skin of those who bathe in it. Certain mineral waters impregnated with sulphuretted hydrogen are well known to change from white to brown the skins of those persons who have been under a course of metallic medicines, or who use metallic cosmetics, and some such circumstance may be the case with the lake in question.

Some lakes are intermittent: the most remarkable of this kind are those of Cirknitz in Illyria, and Kauten in Prussia. They are supposed to be occasioned by a play of natural siphons, upon the same principle as intermittent fountains.

The Lake of Geneva is subject to a subaqueous wind, called the *Vaudaise*, which, rising to the surface, produces an agitation of the water which is sometimes dangerous to the navigation of the lake. Near Boleslaw in Bohemia there is a lake of unknown depth, from the bottom of which there rise, in winter, such violent puffs of wind, that they are said to send up into the air masses of ice of several hundred pounds weight. The sudden escape of gases formed in the bowels of the earth, and perhaps the air forcibly driven out from caverns by the water rushing into and filling them up, may be among the causes of this remarkable phenomenon.

The *Seiches* are a phenomenon which has hitherto been observed only in the Lake of Geneva and some other of the Swiss and Italian lakes, though it is probably common to many others. It consists in an occasional undulation of the water, something like a tide wave, which rises occasionally to the height of 5 feet. Its cause is not exactly known, though it is most probably due to a local and temporary change of atmospheric pressure. Water-spouts are a phenomenon sometimes seen on lakes as on the sea; they have been observed on the lakes of Zürich and Geneva.

Certain lakes seem to be placed in the immediate neighbourhood of centres or foci of electrical attraction; thus in the lake Huron there is a bay over which electrical clouds are perpetually hovering. It is affirmed that no person has ever traversed it without hearing thunder. The proximity of this lake to the American magnetic pole, that is, to the spot where the magnetic intensity is greatest, not where the dip is greatest, may perhaps have some influence in producing so remarkable a phenomenon.

Near Beja in Portugal there is a lake which is said to announce the approach of a storm by a tremendous rumbling. In Siberia also, near the little river Orcibat, which flows into the Abakan, there is, according to Pallas, a lake called the Roaring Lake, from the dreadful noise it makes, and which announces internal revolutions similar to that which occasioned the rupture of the dykes of the Lake Gousinoï in Douaria.

Some lakes have been observed to possess a petrifying or an incrusting property. The latter is merely a deposition of carbonate of lime. This, being dissolved by an excess of acid in the waters of certain springs, is precipitated whenever the waters of these sources coming into the lakes are exposed to the air and lose their excess of acid.

There is an interesting phenomenon presented by the Lake of Zürich, called the flowering of the lake. When this takes place the surface of the water is seen covered with a yellow scum or froth, which upon examination is found to be a very minute vegetation.

There are various other phenomena presented by lakes, but the most singular of them all perhaps is the attractive force of the mud at the bottom of some lakes, which is such that boats can hardly make their way through the water. The Lake Rose and one or two more in Canada are of this kind. Mackenzie describes the fact in these words :—" At the portage or carrying-place of Martres, on Rose Lake, the water is only three or four feet deep, and the bottom is muddy. I have often plunged into it a pole twelve feet long, with as much ease as if I merely plunged it into the water. Nevertheless this mud has a sort of magical effect upon the boats, which is such that the paddles can with difficulty urge them on. This effect is not perceptible on the south side of the lake, where the water is deep, but is more and more sensible as you approach the opposite shore. I have been assured that loaded boats have often been in danger of sinking, and could only be extricated by being towed by lighter boats. As for myself, I have never been in danger of foundering, but I have several times had great difficulty in passing this spot with six stout rowers, whose utmost efforts could scarcely overcome the attraction of the mud. A similar phenomenon is observed on the lake Saginaga, whose bottom attracts the boats with such force that it is only with the greatest difficulty that a loaded boat can be made to advance; fortunately the spot is only about 400 yards over." Captain Back has confirmed the above by later observations.

Lakes differ very much in temperature, transparency, and in the colour of their waters. Lakes fed by the water of melted snows in summer are generally much colder than would be thought conformable with the season; but the difference is principally in the lower waters, which, being cold, remain at the bottom by reason of their greater density. Some lakes never freeze, which is owing to their great depth. This is the case with Loch Ness in Scotland, which is 810 feet deep in the deepest part. Lakes are not subject to tides; at least the amount of tide, so far as observation goes, seems not to be ascertained.

The remarkable transparency of certain lakes is truly astonishing; thus the waters of Lake Superior are so pellucid, that, according to Mr. Heriot, the fish and rocks may be seen at a depth incredible to persons who have never visited these regions. The density of the medium on which the vessel moves appears scarcely to exceed that of the atmosphere, and the traveller becomes impressed with awe at the novelty of his situation. Elliot, in his 'Letters from the North of Europe,' says, " Nothing appears more singular to a foreigner than the transparency of the waters of the Norwegian lakes. At the depth of 100 or 120 feet, the surface of the ground beneath is perfectly visible; sometimes it may be seen wholly covered with shells, sometimes only sprinkled with them; now a submarine forest presents itself to view, and now a subaqueous mountain." In the lake Wetter, in Sweden, it is said a farthing may be seen at the depth of twenty fathoms.

With regard to the colour of lakes, it may be observed that it is sometimes very difficult to account for the tints of large masses of water. The colour of the bottom, the depth, the shadows and reflected colours of surrounding bodies, subaqueous vegetation, springs, and many other circumstances, affect the colour of lakes.

Lakes perform a very important function in the economy of the earth. Rain does not always fall, and were it not for lakes, both visible and subterranean, those great natural reservoirs, the greater number of rivers would be dried up in summer, and canals could not have a constant supply of water. The freshness and humidity which these sheets of water occasion by their evaporation are also eminently favourable to the vegetation in their environs. Many lakes are of sufficient extent to be navigated, and thus facilitate commerce and industry. The fisheries of some are very valuable, and others, by the salt obtained from them, are a mine of wealth. Finally, they most agreeably diversify the surface of the earth by the various appearances which they present of the beautiful and the sublime.

LAMA, LAMAISM, is the name given to the Buddhist religion in Mongolia and Tibet. Lama in these languages properly means priest, but is only applied to those persons who enjoy the higher dignities of the Buddhist hierarchy. It first became an illustrious appellation after the conquests of the Mongols under Genghis Khan and his successors had elevated the individual who pretended to be the successor of Buddha to the dignity of Dalai Lama. The name was first confined to eight subordinate chiefs, who were appointed to act as his council, but was afterwards extended by the Dalai Lama to all other priests who possessed a certain degree of authority. The title of Lama is given to the head of every monastery, and every Lama is considered a vicar of the deity, and requires implicit obedience to all his commands, like the Dalai Lama himself. The opinions of this sect are fully developed in the article **Buddha**; and their religious rites and ceremonies resemble those of the **Bonzes** in Japan.

M. Huc ('Souvenirs d'un Voyage dans la Tarterie, le Thibet, et la Chine, pendant les années 1844, 1845, et 1846,' Paris, 1850), says the Lamas of Tibet are persons of the most limited information, and that their creed is little more refined than that of the vulgar.

The Lamas of Tibet are the physicians; they cure by prayers and some insignificant medicament.

At the Lamasery of Tchort-chi there are 2000 Lamas : it is a favoured place of the emperor, and in it the Mantchou language is taught.

The death of a Grand Lama, says M. Huc, occasions no visible grief or mourning, they only consider the death as a disappearance, and with fasting and prayer the Lamasery await the announcement of his re-appearance. This is revealed by certain augurs, who inform the disciples when and in what place a child will be found in whom the new Buddha has taken up his abode. When found, the child, usually about five or six years old, is examined as to the circumstances of his recent death, and of the events of his previous existence; the answers are usually satisfactory; he is conducted in grand procession to the Lamasery, and becomes at once the Grand Lama of the particular Lamasery, for there is no Tartar kingdom which does not possess in one of its chief Lamaseries a living Buddha.

In all the great Lamaseries are placed barrel-like figures, formed of a number of sheets of paper pasted together, into a thick board, and turning on an axle. On these sheets of paper are written the most usual prayers of the district; and those who want the power or the will to perform long and tedious ceremonies, set this barrel in motion, by which the same effect is produced—the praying and the prostrations are done for them.

LAMIAN WAR. Those cities of Greece which were impatient under the supremacy of the Macedonians regarded Alexander's death as a favourable opportunity to regain independence. In this struggle the Athenians took the lead. They were cordially supported by the Ætolians, both having a private reason for their alacrity in Alexander's avowed design to restore all Greek exiles to their countries. By such a measure the Athenians would have been obliged to cede Samos, part of which they had lately colonised to the expulsion of the former possessors, while the Ætolians had a similar motive in their treatment of Œniadæ. The richer part of the Athenians were very averse to contend again with the power of Macedon; but the poor, who looked to war for pay and plunder, of whom Philip said that war was their peace, and peace their war, carried the point, and ambassadors were despatched through Greece to organise a confederacy, in which the Argians, Messenians, and other states of Peloponnesus, with many of the minor nations of northern Greece, joined. The events of this, which is called the Lamian War, will be found under **Antipater** and **Leosthenes**, in the **Biog. Div.**; and **Athens**, in the **Geog. Div.**

LAMMAS DAY, the name for the first of August, from the Anglo-Saxon *Hlaf-mæsse*, loaf-mass or feast, when the Saxons offered an oblation of loaves made from new corn; other derivations have been given, as Lamb-mass, from the tenants of the see of York having been bound to bring a live lamb into the church at high mass. Brand in his 'Popular Antiquities' speaks of it as still a usage in some places for tenants to be bound to bring in wheat of the year to their lord on or before this day. In the Salisbury Manuals of the 15th century it is called " Benedictio novorum Fructuum." This day had also the name of the Gule of August, as Pettingal ('Archæologia,' vol. ii. p. 67) says from the Celtic Wyl, or Gwyl, a festival. This was the day (the festival of St. Peter's ad Vincula) on which Peter-pence was paid in England while Popery was established.

LAMP-BLACK is a variety of carbon; it is characterised by a total absence of crystalline structure, and by its exceedingly minute state of division. It may be prepared by burning organic matters rich in carbon, with an imperfect supply of air, and providing means for collecting the dense smoke or soot produced. Inferior varieties of resin are sometimes employed as a source of lamp-black, but the material generally made use of is coal-tar. The latter substance, purified to a certain extent by the action of lime and steam, is supplied from a heated main-pipe to a series of small jets, each furnished with a wick, and ignited. Over each burner is fixed a small hood into which the dense smoke passes, and being conveyed along successive series of coarse canvas bags connected together by pipes, deposits its soot or lamp-black on their sides. After the operation has continued for some days, the deposit is shaken to one end of the bag and removed, and the mouth of the bag again tied up.

Lamp-black is largely used as a pigment, chiefly in the manufacture of printers' ink. It always retains a small quantity of undecomposed hydrocarbons.

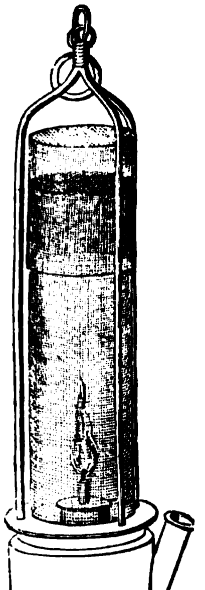
LAMP. [Lights, Artificial.]

LAMP, MONOCHROMATIC. If common salt be dissolved in spirits of wine the mixture will burn with a yellow flame, and if no other lights be burning at the same time, the effects will be extraordinary. An arrangement for furnishing the lamp with a regulated supply of the prepared spirit is termed a *monochromatic lamp.*

LAMP, SAFETY. It has long been known that coal-mines, and especially such as are deep, are occasionally infested with carburetted hydrogen, a gaseous product, which, on account of its combustible property is called *fire-damp;* the word being the equivalent of the German *dampf*, a vapour or exhalation.

Several contrivances had been proposed for safely lighting coal-mines subject to the visitations of this gas; but the safety-lamp of Sir H. Davy was the first one extensively employed. Davy began a chemical examination of various specimens of fire-damp, by which he confirmed the previous statement of Dr. Henry, that the pure inflammable part of it is carburetted hydrogen gas. He found that it required an admixture of a large quantity of atmospheric air to render it explosive. Proceeding with his experiments Davy ascertained that explosions of inflammable gases are incapable of being passed through long narrow metallic tubes; and that this principle of security is still obtained by diminishing their length and diameter at the same time, and likewise by diminishing their length and increasing their number; so that a great number of small apertures would not pass explosion when their depth was equal to their diameter. This fact led to trials upon sieves made of wire gauze. He found that if a piece of wire gauze was held over the flame of a lamp, or of coal gas, it prevented the flame from passing; and he found also that a flame confined in a cylinder of very fine wire gauze did not explode even a mixture of oxygen and hydrogen, but that the gases burnt in it with great vivacity.

The experiments to which we have now alluded, served as the basis of the safety-lamp, which Davy described as follows: "The apertures in the gauze should not be more than $\frac{1}{22}$ of an inch square. As the fire-damp is not inflamed by ignited wire, the thickness of the wire is not of importance; but wire from $\frac{1}{40}$ to $\frac{1}{60}$ of an inch in diameter is the most convenient. Iron-wire and brass-wire gauze of the required degree of fineness are made for sieves by all wire-workers; and except when a lamp is to be used by a viewer for dialling, iron-wire gauze is to be preferred: when of the proper degree of thickness it can neither melt nor burn; and the coat of black rust which soon forms upon it superficially, defends the interior from the action of the air. The cage or cylinder should be made by double joinings, the gauze being folded over so as to leave no apertures. When it is cylindrical it should not be more than two inches in diameter; for in larger cylinders the combustion of the fire-damp renders the top inconveniently hot; and a double top is always a proper precaution, fixed at the distance of half or three-quarters of an inch above the first top. The gauze cylinder should be fastened to the lamp by a screw of four or five turns, and fitted to the screw by a tight ring. All joinings in the lamp should be made with hard solder; and the security depends upon the circumstance that no aperture exists in the apparatus larger than in the wire gauze."



The annexed figure of the safety-lamp requires but little explanation. The cylinder of wire gauze is defended by three upright strong wires, which meet at the top; and to them a ring is fixed, from which the instrument is suspended. The lamp is screwed on to the bottom of the wire gauze, and is supplied with oil by the pipe projecting from it. A wire, bent at the upper end, is passed through the bottom of the lamp for raising, lowering, or trimming the wick. When the lamp is lighted and introduced into an atmosphere gradually mixed with fire-damp, the first effect of the fire-damp is to increase the size and length of the flame. When the inflammable gas forms as much as $\frac{1}{13}$ of the volume of the air, the cylinder becomes filled with a feeble blue flame; but the flame of the wick appears burning brightly within the blue flame. The light of the wick continues till the fire-damp increases to one-sixth or one-fifth, when it is lost in the flame of the fire-damp, which in this case fills the cylinder with a pretty strong light. The operation of the wire gauze in preventing the communication of flame is thus explained:—Flame is gaseous matter so intensely heated as to be luminous. When the flame comes into contact with wire gauze it loses so much heat in consequence of the conducting power of the metal, that it is cooled down below the point at which gaseous matter can remain luminous; and consequently the flame of the gaseous matter burning within the lamp is incapable of passing through it so as to set fire to and explode the mixture of fire-damp. This cooling power is exerted even though the wire gauze, by effecting it, be rendered red-hot.

Although the inventor of this lamp expressed himself fully satisfied of its security, yet others have entertained strong doubts on the subject. During the session of parliament for 1835 a committee was appointed to inquire into the Accidents in Mines. The evidence of Mr. Buddle was strongly in favour of the safety of the lamp; he stated, that for many years he had had not less than 1000, and sometimes 1500 lamps in daily use, and that he never knew in one solitary instance an explosion to happen from them; and he mentioned also that he had been with them in all possible varieties of explosive mixtures. On the other hand abundant evidence, and especially that of Dr. Pereira, was adduced before the committee to show, that in strong currents of explosive mixtures the lamps could not be trusted, as the flame passed through them; indeed Sir H. Davy seems himself to have been aware that an objection might possibly be urged against them on this head, and he proposed the use of a tin shield where such currents occur. Dr. Turner remarks:—"If a lamp with its gauze red-hot be exposed to a current of explosive mixture, the flame may possibly pass so rapidly as not to be cooled below the point of ignition; and in that case an accident might occur with a lamp which would be quite safe in a calm atmosphere. It has been shown by Messrs. Upton and Roberts, that flame may in this case be made to pass through the safety-lamp as commonly constructed; and I am satisfied, from having witnessed some of their experiments, that the observation is correct. This then may account for accidents in coal-mines where the safety-lamp is constantly employed. An obvious mode of avoiding such an evil is to diminish the apertures of the gauze; but this remedy is nearly impracticable from the obstacles which very fine wire gauze causes to the diffusion of light. A better method is to surround the common safety-lamp with a glass cylinder, allowing air to enter solely at the bottom of the lamp through wire gauze of extreme fineness, placed horizontally, and to escape at top by a similar contrivance."

In mentioning the names of other inventors of safety-lamps, we must especially allude to the late George Stephenson; because some injudicious friends of Davy have sought to brighten the fame of that great chemist by disparaging the self-taught engineer. In 1815 Stephenson was engine-wright at the Killingworth Colliery, near Newcastle. Terrible explosions having taken place, he turned his ingenious mind to the devising of some kind of lamp which would not prove dangerous. Dr. Clanny of Sunderland had taken up the subject two years before, but had not yet surmounted the difficulties. In the month of August, Stephenson drew out a sketch for a lamp, which, after conferring with Mr. Nicholas Wood and other colliery engineers, was sent to a lamp-maker at Newcastle. The new lamp was ready on Oct. 21st, and was tried successfully on the same day. Stephenson then made a few improvements, and caused a new lamp to be ready by Nov. 4th. Again he experimented and made improvements, and a still more complete lamp was ready by Nov. 30th; and the "Geordy" lamp, as the miners familiarly called it, at once came into use at Killingworth. During these very months Davy was at work on the experiments which led to his safety-lamp; and it is now clearly proved, by the evidence collected in Smiles's 'Life of George Stephenson,' that the illustrious chemist and the humble engine-wright arrived by wholly independent paths at a knowledge of the facts concerning the passage (or rather the non-passage) of flame through tubes and small apertures. The coal-miners of the north did justice to Stephenson in a very public way in 1817.

The merits and defects of safety-lamps have formed a subject for many committees of inquiry. The parliamentary committee of 1835 has already been adverted to. A great explosion near Sunderland in 1839 led to the formation of a South Shields committee, the members of which devoted three years to the collecting of evidence relating to the causes of colliery explosions; and one of the results to which they arrived was, that the safety-lamp might in some circumstances be a source of danger rather than security, if it induced a neglect of measures for ventilating the mines. There was a committee of the House of Lords appointed in 1849 to inquire into the causes of these terrible disasters; this was followed by similar committees of the House of Commons in 1852 and the next two years; and the result of all the inquiries was to show that any one among a large variety of safety-lamps would render useful service, provided care be taken in the using. It is, however, painfully evident that this amount of care is *not* always taken; for the miners are too often thoughtless in the use of their lamps.

In briefly noticing some among the many kinds of safety-lamp devised since the time of Davy, it may be useful to mention that they depend for their safety on two principles—the obstructive action of wire-gauze, and the protective shield afforded by a glass cylinder. Of the Davy lamp enough has been said in former paragraphs; the method of arrangement has only been slightly altered since his day.

The Stephenson lamp has a glass cylinder inside the wire-gauze cylinder. The air is supplied through a triple circle of small holes in the metal bottom. Inside the top of the glass cylinder is a sort of metal chimney full of small holes. The lamp gives a steady light by being protected from the currents of the mine. It has a few advantages over the Davy, but is generally considered by miners not quite equal in security to some others presently to be noticed. If the glass cylinder breaks, the lamp becomes a common wire-gauze lamp, but with rather too large a diameter; for it is found that if the diameter be more than about 1½ inches, too great a volume of explosive gas might be contained within it.

The Smith lamp, a modification of the Stephenson, admits the air through the wire gauze as well as through the perforations in the metal plate; and there are other arrangements for preventing the stoppage of the perforations by dust and oil—an evil to which the Stephenson lamp is subject.

The Clanny lamp has an apparatus for extinguishing the flame in an explosive mixture, when the flame is of sufficient strength to extend itself high in the lamp. The flame melts a thin wire, which lets fall a shield or extinguisher, so placed as to put out the *gas*-flame, leaving a very small *oil*-flame sufficient to light the miner away from the dangerous place. Dr. Clanny has devoted a large amount of attention to the minor details of the lamp, especially to the mode of admitting air for combustion.

The Upton and Roberts lamp has a glass cylinder *outside* the wire-gauze cylinder. The air is admitted through horizontal apertures just over the oil-vessel, and then has to follow an intricate route before it can touch the wick. As a warning of the presence of foul air in the mine, it is the most sensitive of all the safety-lamps; but this sensitiveness is the very cause of the lamp not being much used, for its light is either dimmed or actually put out by causes very likely to occur in a coal-pit; and the miners hence dislike it, although it is spoken very highly of by scientific men, who test it in their laboratories.

The Martin lamp has no wire-gauze. The air is admitted through perforations in a metal bottom to the wick. The body of the lamp is a glass chimney, on the top of which is a copper chimney contracting gradually to a cone. It is very delicate in its action, extinguishing itself almost on the approach of carburetted hydrogen. This would, however, render it useless in a very fiery mine; besides which, an unprotected glass cylinder, without wire-gauze inside or out, is considered dangerous.

The Ayre lamp has an arrangement by which the air passes through a valve; the valve closes whenever the atmosphere becomes light or filled with foul gas, and thus extinguishes the lamp.

The Muessler lamp, much used in the Belgian coal-mines, is larger than the English lamps. A glass vessel surrounds the flame. The air can only reach the flame over the top of the glass, which is covered with wire-gauze. Over the glass, and as a continuation of it, is a wire-gauze cylinder, having a brass top full of minute holes. A small metal chimney pierces the horizontal disc of gauze which covers the glass, to give an outlet for the flame and the products of combustion. The air must pass downwards through this lamp before it can reach the wick. The Muessler lamp gives a good light, and is very safe against explosive mixtures; but it is heavier than the English lamps, and its unprotected glass vessel is liable to fracture; moreover, if held a little sloping (which is very likely to occur in use), the flame goes out.

The Lemielle lamp, also used in Belgium, is a sort of Davy lamp, with a glass cylinder fitting tightly inside it, and extending about half the height. The wire-gauze is spread out at the bottom into a trebly-thick flat rim; and the arrangement is such that the air to feed the flame must pass down through the treble gauze rim into a space between the top of the oil-vessel and the wick, and then up again to the wick in the narrow glass cylinder.

The Whitehead lamp consists of an iron cylinder, with on one side a bull's-eye surrounded by reflecting surfaces. The air to support combustion passes through a number of small orifices round the oil receptacle, and thence through wire-gauze. The air admitted is purposely small in quantity. Wire-gauze is also introduced at the top of the chimney, so as to complete the isolation of the flame.

There are many other forms of safety-lamp which have engaged the attention of practical men,—such as Elsin's, a Belgian lamp intended to give more light than is usually obtained; Fyfe's, something like Clanny's, but having double gauze at the top instead of single; Watson's, which has apparatus for locking up the lamp in such a way that the miner cannot open it until it needs to be trimmed; Henderson's, with a double glass cylinder, having water between to cool the outer glass; Boty's, a Belgian lamp with gauze and glass; Martyn Roberts's, having a contrivance for extinguishing the flame if the lamp should be broken; Glover's, having two concentric glasses, and an arrangement for making a current of cool air circulate between them. Some have been made with the wire-gauze electro-silvered, in order to reflect more light; seeing that it has been found by Mr. Goldsworthy Gurney, that when dull iron wire is used, three-fourths of the light is lost.

Amid much diversity of opinion concerning the relative merits of these various kinds of safety-lamp, there is a pretty general agreement that the gauze cylinder should be accompanied by one of glass, to resist the action of strong currents of air; and that the glass without the gauze is not sufficiently protected against fracture.

LAMPIC ACID. Another name for *Aldehydic acid.* [ALDEHYDIC ACID].

LAND, in its most restricted legal signification, is confined to arable ground. In this sense the term is used in formal pleadings.

By the statute of Wills (1 Vict. c. 26), a devise of the land of the testator is to be construed to include customary, copyhold, and leasehold estates to which the description will extend, as well as freehold estates, unless a contrary intention appear. In its more wide legal signification land extends also to meadow, pasture, woods, moors, waters, &c.; but in this wider sense the word generally used is lands: the term land or lands is taken in this larger sense in conveyances and contracts.

In conveying the land, houses and other buildings erected thereon, as well as mines, &c., under it, will pass with it, unless specially excepted. A grant of the vesture of certain land is more restricted, and transfers merely a particular or limited right in such land, and the houses, timber, trees, mines, and other real things, which are considered as part or parcel of the inheritance, are not conveyed, but only corn, grass, underwood, &c., the produce of the land. Other limited or particular rights, as fishing, cutting turf, &c., may be granted, which confer no interest in the land itself, or, as it is called, the realty, but only the benefit of such particular privileges. But a grant of the fruits and profits of the land conveys also the land itself. Absolute ownership of land carries with it the right to the possession downwards of the minerals, waters, &c., and also upwards, agreeably to the maxim, "cujus est solum, ejus est usque ad cœlum."

Ownership of land is expressed in the English law by the term *real* property, in contradistinction to *personal* property, which consists in money, goods, and other moveables.

Land is legally considered as enclosed from neighbouring land, though it lie in the middle of an open field, and may therefore be called a *close;* and the owner may subdivide this ideal close into as many ideal parcels as he pleases, and may, in legal proceedings, describe each of these parcels, however minute, as his close. An illegal entry into the land of another is therefore called, in law, breaking and entering his close, and the remedy is by the action of trespass, "Quare clausum fregit."

Land derelict, or left dry by the sudden receding of the sea, or of the water of a navigable river, belongs to the king by his prerogative; but land formed by alluvion, that is, by gradual imperceptible receding of any water, or by a gradual deposit on the shore, accrues to the owner of the adjoining land.

The word *land* is, by the interpretation clause of many statutes, as well public as private, made to include every species of real property and every denomination of right and interest therein.

(*Doctor and Student; Co. Litt.;* Comyn's *Dig.*)

LAND TAX is a branch of the public revenue of England, which was first raised in its present form in 1692. It was contrary to the spirit of the feudal system that pecuniary assessments should be made upon land held by knight's service, the personal military services of the tenants being in this and in other countries considered as entitling them to exemption from tallage, or direct taxation. The first inroad upon this principle in England was the payment of escuage as a commutation for personal service. This was followed by pecuniary grants made by parliament in the form of subsidies upon the abolition of the military tenures by the Long Parliament, which was afterwards confirmed by the first parliament of Charles II.; the ground of exemption ceased, and land as well as personal estate was made the subject of assessment.

Until 1799 the land-tax was granted by parliament for only one year, and the acts under which it was levied were renewed annually; but in that year an act was passed rendering the tax perpetual, the object of this alteration being to facilitate the raising of money by means of its redemption. Under the conditions of this act the tax was offered for sale first to the owner of the land upon which it was chargeable, and if the purchase were declined by him then to any other person, in which latter case the purchaser was to receive the amount half-yearly from the receiver-general. The payments were in either case to be made not in money, but by the transfer of an equivalent amount of the national debt. The advantage stipulated on the part of the public was, that if redeemed by the owner of the land, the interest or annuity transferred in payment should exceed the annual amount of the tax redeemed by 10 per cent.; and if purchased by an indifferent party, that the interest or annuity should exceed that annual amount by 20 per cent.: for example, if the land-tax to be redeemed by the owner amounted to 5*l.* per annum, the sum of 3 per cent. stock to be paid for the same would be 183*l.* 6*s.* 8*d.*, the annuity in respect of which would be 5*l.* 10*s.*, or 10 per cent. advance upon the tax. If the purchaser were a stranger, the amount of 3 per cent. stock would be 200*l.*, or an annuity of 6*l.* per annum, being 20 per cent. advance. This measure met with only a partial success, which occasioned several modifications to be made in its terms with the view of rendering them more acceptable to the landowners. The most important of these modifications were passed in 1811 and 1812, when the management was transferred from special commissioners to the Commissioners for the Affairs of Taxes; the preference given in previous acts to the owners was revoked, except as regarded priority where competition appeared, and the purchase-money was made payable by thirty-two half-yearly instalments.

The rate at which this tax is charged is 4*s.* in the pound on the annual value, as rated at the time of imposition. Consequently the produce varies but little, ranging between 1,100,000*l.* and 1,200,000*l.* For the year ending March 31, 1859, it was 1,100,081*l.* for England, Wales, and Scotland. Ireland is exempt.

LANDGRAVE. In the early history of Germany the *Grave* was an inferior judge, who was chosen by the people for his experience in business. Under the Franks the Graves were no longer chosen by the people, but appointed by the kings or emperors, and were judges of a province; above them in rank were the Herzogs, or dukes; and below them the Gaugrafs, or judges of a district (called a *Gau*) a division of which there are still some traces in Germany, as the Rheingau and the Vinschgau, in which they exercised the rights of government in the king's name, having especially the administration of justice, the police, and the royal revenues. After the time of the Carlovingian kings the following classes were distinguished: *Palgraves* (Pfalzgraf, from *pfalz*, court), who sat in judgment at the king's court, and examined whether a suit must be decided by the king himself; *Margraves* (properly *Markgraves*, Markgraf), from *mark*, a frontier or boundary, who were keepers of the frontiers (lords of the marches); and *Landgraves*. Nearly all these titularies, however, soon made themselves independent of the sovereign. The Markgraves of Thüringen assumed the title of Landgraves towards the end of the 11th century, and it was obtained in the next century by the Graves of Hesse, in whose dominions the title is still borne by the Landgraf of Hesse Homburg, while the two elder branches have assumed the titles—the senior that of Elector of Hesse Cassel, the second that of Grand Duke of Hesse Darmstadt.

LANDING-STAGE, a structure erected upon the banks of a river, quay, or dock, for the purpose of facilitating the discharge of goods, or the landing of passengers, from the vessels frequenting the particular port or locality under consideration. Landing-stages under these circumstances may either be fixed, as in the majority of docks, where they are provided with hand, steam, or hydraulic cranes, or with other machinery for facilitating the operations of unloading; or they may be floating, as in the various passenger stations upon the Thames, or upon the Mersey, Frith of Forth, &c. The variable conditions of the loads to be discharged, in the first case, and of the rise of tide, or of the variations of the surface lines in the second, introduce such countless modifications into the details of landing stages, that it becomes impossible to lay down any general rule with respect to them; it may suffice, therefore, to refer to the landing stages at Liverpool; at Blackfriars Bridge, London; at the Albert Docks, Liverpool, the Regent's Canal Docks, and the Victoria Docks, as illustrations of this class of structures in some of its more striking modifications. In passenger-landing stages there should be provision made for booking, and for checking the arrival of travellers; and in goods landing stages there should be ample means for weighing, measuring, sampling, or packing the goods; in both of them, the vessels to be unloaded should be able to lie out of the ordinary course of the ships frequenting the particular place, and be able to cast off easily into the open water when required. The Brighton chain pier, and the landing stage of a somewhat similar character erected by the late Sir I. Brunel at the island of Bourbon, may be referred to as amongst the most remarkable landing stages on exposed coasts.

LANDING-WAITER, an officer of the customs, whose duties consist in taking an accurate account of the number, weight, measure, or quality of the various descriptions of merchandise landed from foreign countries or colonial possessions. Landing-waiters likewise attend to the shipment of all goods in respect of which bounties or drawbacks are claimed. These officers are likewise called searchers.

LANDLORD AND TENANT. [TENANT AND LANDLORD.]

LANDSCAPE GARDENING. [GARDEN.]

LANGUAGE, taken in its most general sense, may be defined as the means by which the thoughts of one mind are conveyed to another mind; and it may be assumed, as a self-evident proposition, that the channel must be one or more of the senses. Of these the most available are of course the sight and hearing, but not to the exclusion of the others. Thus the sense of smell is turned to account when the blood-hound is employed to track a fugitive, but the materials at hand for action on the nostrils, the *copia narium*, must needs be limited, nor would any reference to this sense, or that of taste, have been made on the present occasion but that it is always desirable in an inquiry, to cast a look, however transient, over the whole field. While visible language is employed chiefly for the purpose of recording knowledge, there are cases where it is needed for immediate use. Thus, to take the case of the deaf man in the farce of 'Boots at the Swan,' a series of inefficient attempts on the part of a traveller to procure refreshments by verbal orders, when followed by a few movements of the hands, as of cutting food in a plate and conveying it to the lips. The captain again on the bridge of a steamboat, amid the noise of passengers and weather, by previously concerted movements, conveys his orders either to the boy above the engine or to the sailor at the helm. In those sad, but happily rare, cases, where the channels of the eye and ear are both closed, time was when the unhappy sufferer was left to a life of worse than brutal torpidity; but by modern science the sense of touch alone has been made to supply in some measure the deficiency, as in the well-known case of Laura Bridgman. The language then of the eye and the ear need alone claim our attention. Some remarks on the comparative advantages of these two forms of language have already been given in a previous article [ALPHABET]. It may be sufficient on this head to notice the not unimportant fact, that it may often be advantageous to call the visible in aid of the oral language. Thus a shrug of the shoulders, a stamping of the foot, and movement of the hand in various ways, often add much to the intelligibility of a speaker.

In an endeavour to find out the origin of oral language, an inquirer is met by difficulties—some imaginary, some real. That the task is no easy one is seen at once in the fact that historical aid can be of little value, inasmuch as, from the nature of the case, written language belongs to a much higher civilisation than that which was contented with the language of sounds. On the other hand, little weight need be given to the doctrine occasionally put forward, that the attempt in itself savours of impiety, especially when the invention is ascribed to man's own efforts under the stimulus of the wants which social life brings with it. The Book of Genesis, it is now admitted by our best informed divines, was not written to form a code of science; yet, taken in its most literal sense, the Mosaic account, instead of justifying the assertion of a living writer, that God gave man language, expressly ascribes the immediate invention to Adam. The most scrupulous theologian therefore, will have no reason to quarrel with the views about to be put forward. Others again treat the problem as one insoluble for us. "How this latent power evolved itself first," says the writer already alluded to, "how this spontaneous generation of language came to pass, is a mystery, and as a mystery all the deepest inquirers into the subject are content to leave it." Let us hope that an attempt to throw a wet blanket on the inquiry will not be successful. In all departments of knowledge, "the impossible" has again and again been accomplished, and the solution has usually been effected by the establishment of principles not more remarkable for power than for simplicity. We think it the more important to urge this law of simplicity, as marking all just explanations of natural phenomena, because a certain love of the mystical has induced some modern writers to shut their eyes to what is really most simple in the present inquiry. The same writer, who has many claims on public attention, while he admits that man has adorned and enriched his life with various arts and inventions, objects to the theory that in like manner he invented language. To the doctrine, that from rude and imperfect beginnings, the inarticulate cries by which he expressed his natural wants, the sounds by which he sought to imitate the impression of natural objects upon him, man by little and little arrived at that wondrous organ of thought and feeling which he now possesses, he opposes the objection that language would then be an *accident* of human nature, forgetting that it is one of those accidents which must have occurred, so that chance at once merges in certainty. Moreover, what valuable and permanent results may come out of mere accident, has been shown of late in the highly philosophical doctrine of "Natural Selection" in the animal and vegetable kingdoms.

It was long contended that the significancy attached to sounds was altogether conventional. Thus the author of 'Hermes' (314) says: "The meaning of language is derived from compact." No doubt this theory of arbitrary signs is in itself thoroughly intelligible. The signal-flags of a fleet, the oscillations of the needles in a telegraph office, owe their value entirely to a previous understanding; but the explanation is utterly without solidity for oral language, inasmuch as we cannot easily imagine a man possessed of sufficient authority to dictate such arbitrary laws, or able to make known his wishes. Add to this the consideration that the absence of all natural connection between the significant sound and the thing signified, would render it the more difficult both to acquire and to retain a language so constituted. The theory then that would found language on the assumption of a compact, may be left to share the fate of other similar theories, such as Rousseau's 'Contrat Social.' On the other hand it is now all but universally admitted that some portion of language at any rate, owes its origin to an imitation of the sounds that occur in nature. The *moo-cow*, the *baa-lamb* of the child, the *cuckoo*, the *peewit*, the *whip-poor-will*, *the tuco-tuco*, are simple but irresistible examples of this law; and we have the same principle presented in the dialogue over the Chinese banquet, when, as the tale goes, an English visitor endeavoured to extract from the native waiter a little information as to the dish he was eating by the inquiring words "quack quack, eh?" and received the more intelligible than welcome answer of "bow-wow!" But if the imitation of actual sounds admittedly supplied one part of language, is it an overbold supposition that all language came from this source? Not that it is to be expected that in each individual case we should succeed in tracing up the meaning of a word to its onomatopoetic progenitor, for words are incessantly modifying their meaning, and the principle of association by which this result is effected, is often difficult to follow. No better proof of this difficulty is to be found than in the fact that the same word has occasionally obtained meanings diametrically opposed to each other. Thus the Latin noun *species*, lit. 'sight,' is at one time employed to denote what a person *seems* to himself to see, and thus we have a class of meanings denoting what is utterly unreal, just as our language owes to the same stock its nouns *specious* and *spectre*. At other times it has meanings in keeping with the doctrine that "seeing is believing," and it is in this way that we have in use the terms *specie*, "solid bullion," as opposed to paper money, and *spice*, which at one time vied with gold itself in value, So the learned Dean of Westminster points out that *impatientia* has borne at different times the opposite meanings of "impatience" (non-enduring) and "apathy" (non-feeling).

But to return to the subject of the formation of words on the principle of natural imitation, it is important to notice that there are those who would draw a line, by which words so formed are separated from the large residue of language. Thus there was published a few years back, a valuable paper by Buschmann, in the 'Transactions of the Berlin Academy,' in which he traces through the languages of the world the terms for the leading relations of family, as *father* and *mother*, and so establishes a remarkable similarity of forms over the whole surface of our globe. Another German writer in the 'Transactions of the Philological Society' (1859, pp. 34-36), has done the same for the pronouns of the first and second person. It matters little for the present purpose that the two writers, here spoken of, refuse to see in this identity of results a proof of the historical unity of mankind, contending that it can only prove the ideal unity of human nature; meaning, it is supposed thereby, that different races of men may owe their possession of these words in common, not to tradition, but to the working of similarly constituted minds under similar circumstances. For our present inquiry it is enough that they fully admit the development of these words on natural principles, as opposed to any arbitrary law of dictation.

But if the view which ascribes the origin of words to onomatopœia be universally true, it will follow that the first development of language was the formation of active verbs, inasmuch as it is by action alone that noise can be produced. This proposition is in no way opposed to the commencing observations that the *moo-cow* and *bow-wow* owe their names to this principle; for the words *moo* and *bow-wow* denote first the act of lowing and barking, and then give a name for the beings that low and bark. Moreover, by the term active verbs are here meant not merely transitive verbs, as *strike*, but equally the intransitive, as *walk, run*, to the exclusion of all verbs denoting a mere state, whether of body or mind. This doctrine, which assigns a sort of primogeniture to the verb, receives no little support from the Arabic, which expresses the grammatical idea of a verb by a word strictly denoting action. (De Sacy's 'Grammar,' § 245.) Similarly the Chinese (Endlicher's 'Grammar,' § 219) denotes the same idea by *sing-tsé*, "living words," or *hŏ-tsé*, "words of motion;" whereas for nouns the terms in use are *ssè-tsé*, "dead words," or *tsing-tsé*, "quiescent words." Precisely in agreement with this, the terms *verbum* of the Latin, and *ῥημα* of the Greek, being limited to the verb, although etymologically they signify merely that which is spoken, imply thereby a marked supremacy for this part of speech. Nor is there much force in the argument of an able writer in the 'Proceedings of the Philological Society' (3, p. 163), that in many languages the same word is used alike for a verb and an abstract substantive of kindred power; as in Coptic, *ti* signifies indifferently "give" or "giving," so that with a pronominal affix there occurs *ti-k*, "giving of me," and with the further addition of a noun we have *giving of me this*, in the sense of *I give this*. When the writer in question gives to such a form as *ti* the title "nomen actionis," he really concedes all that is asked, for there cannot be found a better definition of a verb as here used.

Not a little support for the doctrine now maintained exists in the fact that the moment the idea of feeling is to be represented, the older forms of language exhibit an antipathy to the simple personal verb. Thus the Latin language abounds in such forms, as *pudet me ejus, tædet, pænitet*, &c.; as also in reflective verbs, such as *reminiscor, obliviscor, vereor, misereor*. Other languages exhibit a similar peculiarity: as the Greek, in *δει, ἐλπομαι, οπτομαι*; the German, in *es gereuet mich*, "I repent;" *es friert mich*, "I am chilled;" *es ahnet mir*, "my mind forebodes;" *es ekelt mir*, "I loath;" *es träumt mir*, "I dream;" while in our own tongue we have still *methinks;* and the older language had *me-seems, it likes me*. Thus we have in Shakspere the phrases: "An't like your grace" ('Measure for Measure,' v. 1); "His countenance likes me not" ('King Lear,' i. 1); "I'll do it, but it dislikes me" ('Othello,' ii. 3). Similarly, our verbs *fear, remember*, and *repent*, to take them as specimens, had the active sense before they were employed as verbs denoting a state of mind; or perhaps it would be more accurate to say, before they were used as reflectives. Thus, still to quote from our great poet: "Tush, tush, fear boys with bugs" ('Taming of the Shrew,' i. 2); "Her wits, I fear me, are not firm" ('Measure for Measure,' v. 1); "How I may be censured, something fears me to think of" ('King Lear,' iii. 5). Again: "Thou but remember'st me of mine own conception" ('King Lear,' i. 4); "And now I am remembered, scorned at me" ('As You Like it,' iii. 5). So, also: "I do repent me that I put it to you" ('Othello,' iii. 3); "I can again thy former light restore, should I repent me." And in the Bible: "It repented the Lord that He had made man" (Gen., vi. 6). Another proof that the verb of action belongs to the earliest state of language is found in the brevity of form which characterises this class of words. Thus the Latin so-called third conjugation consists chiefly of verbs which denote the simplest acts; and the special character of this conjugation is brevity, the roots consisting largely of a vowel flanked by single consonants; and if the other conjugations possess a few monosyllabic verbs, these also stand out from among their neighbours, as having a similar form of meaning. But, of course, in speaking of such verbs, we discard from view those suffixes which denote the persons, and further reject those modifications, whether of a lengthened vowel or doubled consonant, which are commonly employed solely for the purpose of denoting an imperfect, or rather continued, character of action, by compelling the voice to dwell longer on the sound. Thus, to take our examples from the Latin, we have the verbs, *dŭc*, "lead;" *dĭc*, "say," or rather "show;" *fac*, "do;" *cad*, "fall;" *ser*, "sow," or rather "put;" *vel*, "pull;" *mit*, "let go;" *da*, "give," or rather "put;" *i*, "go;" *su*, "sŏw." The other conjugations have their chief employment in denoting either a state or a succession of acts, as *ama, frica, vide, alge, dormi, audi, volu, metu:* or, to mark the contrast better, we may point to such pairs of words as *iac*, "throw;" *iace*, "lie;" *sĕd* (*sid-ĕre*), "take a seat;" *sĕde*, "be seated, sit;" *cap*, "take;" *habe*, "have;" *ten-* (*tend-ere*), "stretch;" *tene*, "hold tightly, grasp."

The one main argument which may be opposed to the views here put forward is the doctrine, favoured by many grammarians, that all sentences ought to be reduced to the logical form, consisting of a subject, predicate, and copula. That this view of language is all-important for the syllogism, and consequently for argument, is admitted. It is not admitted that the first object in the formation of language was argument. An earlier and more important object was to enunciate facts and to give commands. In truth, the process by which a logician forces (for it is often sheer force) every sentence into his favourite form, so as to exhibit the so-called substantive verb, is altogether artificial; and not a little harm has been done to grammar by regarding language solely from the logician's point of view. Thus we find De Sacy, in his 'Grammaire Arabe' (tome i., § 246), expressing himself thus:—

> Le seul verbe, qu'on puisse regarder comme absolument nécessaire à l'expression des jugemens de notre esprit, c'est celui qu'on nomme *verbe substantif* ou *abstrait* tel que *esse* en Latin, *être* en François. Celui-là seul ne renferme précisément que ce qui constitue essentiellement la valeur du verbe, l'idée de l'existence du sujet avec relation à un attribut.

Now there is not an idea more difficult of distinct comprehension and definition, even to the most highly educated, than that which is denoted by the term *existence*. In truth the verb *to be* may well be called *le verbe abstrait* by De Sacy; but an abstract term, however essential to a system of metaphysics, is among the very last that is called for under the wants of uncivilised society. The savage has his various terms for the several concrete forms of existence, but has no occasion for a general term; and in fact those who attempt to translate the language of a nation far advanced in civilisation into the language of a rude tribe, find an insuperable difficulty in words of this class. But on this point we may be satisfied with the evidence of one, whose extensive acquaintance with the most outlying language made him the best of witnesses, especially as his feelings were directly opposed to the doctrine of the verb here advanced, so that he could not be suspected of any too favourable bias. In vol. iv., p. 70, of the Proceedings of the Philological Society, Mr. Garnett writes:—"We may venture to affirm that there is not such a thing as a true verb-substantive in any one member of the great Polynesian family." Again, in p. 236, he expresses his belief that "a verb-substantive, such as is commonly conceived, vivifying all connected speech, and binding together the terms of every logical composition, is much upon a footing with the phlogiston of the chemists of the last generation." De Sacy also, though he lays down the doctrine that the verb *to be* is the only essential verb, was aware that in many languages the connection of the subject and predicate was denoted without the interposition of any verb; and, indeed, that in the Arabic itself a verb was no way essential for the purpose. In our own family of languages it is the fashion to give a sort of precedence to the Sanscrit as the most perfect specimen; and here again the expression of a logical proposition altogether dispenses with a copula. Now, when we put together the several considerations that the logical form of language is not that which adapts itself to the wants of early society; that the substantive verb so-called is not even requisite for the expression of logical ideas; that the idea of *being* in the abstract is beyond the comprehension of a savage; and that in point of fact a large number of existing languages do not possess such a verb, surely it is highly unphilosophical to construct a theory of language on such a basis. But there still remains a difficulty to be disentangled. It has been truly laid down that the most irregular verbs of a language are the oldest; and it may be safely affirmed that of all verbs the most irregular is that which signifies "to be," as is seen in *be, is, was*, of our tongue, *esse, sum, fui*, of Latin. The solution of the difficulty is found in the fact that *esse* had for its oldest meaning "to eat," and not "to be." The idea of eating is of course ever before the mind of the savage, simply because the fear of starvation is too constant a condition of his life, and may well claim an early place in his vocabulary. Nor is it difficult to see how from "to eat" comes the idea of "to live," or to deduce from the latter notion that of existence in general. Thus the authoress of 'A Residence at Sierra Leone' in Murray's Colonial Library, found the natives wholly unable to follow the use of our substantive verb, and was compelled at last to substitute *live* for *be*, before she could make herself intelligible. "Go fetch big tea-cup, he *live* in pantry," was the kind of language she found it necessary to employ; and the servant in announcing dinner would say:—"Dinner *live* on table."

To reject the logical view of early language involves, of course, the rejection of the usual definition of the nominative, as the subject of the proposition. If the original verbs were limited to those which express action, a necessary consequence would be, that the nominative denotes the agent. This consequence may be readily admitted, and the more so, as it meets what seems to be a grave difficulty. A linguistic paper by Carl Bock, published in 12mo. at Berlin, in the year 1845, under the title 'Analysis Verbi,' drew attention to the fact, that in some languages the personal suffixes exhibited the form of genitives; and Mr. Garnett's paper, already quoted, produces other examples of the same apparent anomaly. But the moment that the idea of an agent or cause attaches itself to the term nominative, the difficulty vanishes, since the leading meaning of the genitive is the source "whence," as *calor solis* "the heat *from* the sun." And if it be objected to the theory, that the nominative is also used in connection with the passive, the simple answer is, that the passive was in origin a reflective, or, as our Greek grammarians prefer to say, a middle voice, so that the first translation of *servus occiditur* is "the slave kills himself;" and further it may be noticed, that when the Latin, using the passive, wishes to define the agent, it gives us *servus a domino occiditur*, which, compared with the equivalent phrase *dominus servum occidit*, teaches us that *dominus* in the one, and *a domino* in the other, express the same idea, the very point for which we are contending.

But if in one of the simplest sentences of the primeval language, the nominative denoted the agent or quarter "whence" the action proceeded, so, on the other hand, the accusative must have denoted the "whither;" and this result thoroughly accords with the habit of language. Thus Varro expressly defines the Latin accusative as answering to the question *quo*, "whither." It agrees too with the use of the accusative in such a phrase as *Romam eo*, "I am going *to* Rome," and with the Spanish practice of inserting the preposition *a*. "to," before the object of a sentence. And as it has been shown that the ideas of feeling required a wholly different construction from verbs of action, so here again the former class in the oldest varieties of language exhibit an antipathy to an accusative and indeed very generally demand a genitive to denote the object of the feeling, or as we should rather express it, the cause or source of the feeling. Thus arose such constructions as: *me* tui *pudet*, *memini* virorum, "*venit mihi* Platonis *in mentem*;" and if we go back to the earliest Latin, "*quæ non veretur* viri" (Afran.), "*fastidit* mei" (Plaut.), "Justitiæne *prius mirer belline* laborum?" (Virg.) And we find parallel examples in English, as it used to be spoken, as "Thou dislik'st *of* virtue." (Shakspere, "All's Well that Ends Well," ii. 3.)

One decided example of a verb formed by imitation of natural sound must suffice in a short sketch such as the present. When a stone tied to a string is whirled violently round, or when we enter a room where machinery with its many wheels is in rapid movement, the ear catches very distinctly the sound which we may represent by *whirr*. Now *wirr-en*, is the German "to twist," *vi-rer*, in French, "to turn;" while we apply the term *wear* to the turning of a ship, and *veer* to the turning of a weathercock. The same root is seen in the English secondary or derived words, *whirl*, *whorl*, *world*, *warp*, *worm*, *writhe*, *wreath*, *wrench*, *wrest*, *wrist*, *wring*, *wriggle*, *wrap*, *wry*. The Latin language exhibits the same base in *ver-t-ere*, "to turn," *ver-u*, "a spit," *vermis*, "a worm," *verminari*, which signifies indifferently "to breed worms" and "to writhe with pain," meanings which, however different in application, have in common the idea of turning. The adjective *varus*, "with crooked legs," and *varices*, "varicose veins" have the same origin. But the sound passes at times into a something which we may express by the softer and more musical *wel*, and then we have it in the sense of the Greek *Ϝελ-ισσω*, *Ϝελ-ιξ*, *Ϝελ-ι-τροχος*, *Ϝειλω*, *Ϝειλυω*, the Latin *vol-v-ere*, *val-va*, *val-gus*, "with crooked legs," and as might easily be shown, if more room were at our disposal, *volgus* and *volgare*. In our own language we have *wheel*, *wall-ow*, *welter*, while the Germans have both the simple verb *wall-en*, "to roll," and the derived *wal-gen*, and *walz-en*. The list might be still further increased, if we called to mind that many words which now begin with *r* have lost a preceding *w*, as *rota*, *rotundus*, in Latin, equivalent to *vortu*, *vortundus*, and in English, *roll*, *ring*, sb. *ringlet*. The Latin *orbis* has also lost an initial *v*, just as the Danish *orm*, 'worm,' has lost a *w*.

Before passing from the question of original roots and their signification, it seems due to the name of the German scholar, Bopp, to record that in his view ('Vergleichende Grammatik,' § 105) the main principle of word-formation in the Indo-European class of languages consists in the union of verbal and *pronominal* roots, which, to borrow his image, represent as it were the body and soul of language. It does not appear that many philologers have followed him in this doctrine. But the unsoundness of it seems almost to force itself on the mind in the very term "pronominal." In fact pronouns are scarcely of a character to have been part of any language in its earliest stages, simply because they are, as their name tells us, but substitutes for other words; and assuredly a language might have attained to a very valuable consistency without the possession of a single pronominal word. Reasons will presently be given for referring a large majority of our third person pronouns to one single verb; and the pronouns of the first and second persons seem also entitled to claim a close connection with some of the numerals, of which more presently. In the meanwhile the readers of Bopp's great work may be asked to notice the tendency in that writer to refer the presence of an inconvenient vowel in word-formation to the presence of some pronominal base—now *i*, now *a*, now *ya*, &c., without much consideration of any meaning the too convenient pronouns bring with them to the word in which he finds them.

From the question of monosyllabic roots the next step should be the principle of word formation or derivation; but a preliminary matter presents itself. There are those who would divide languages into genera, and claim for each a special formation. Thus we read of monosyllabic and polysyllabic languages, languages with triconsonantal roots, a synthetic or analytic method of formation, words formed by agglutination and others by internal change of the root syllable or syllables; and lastly, affixes are treated by this writer as having in themselves no signification, by another as expressing the additional idea which their addition carries to the root-syllable or simpler word. In all this there appears to be a very large proportion of error. A deeper examination of languages will perhaps always lead to a common result, that the roots were originally of one syllable, and that longer words are formed by the agglutination of such roots, with the understanding, however, that the affixed syllables, though in themselves originally roots, play commonly a less important part in the construction of the composite word. It may be useful to point to the causes which have given currency to the errors we have been speaking of. To begin with the Chinese language and others commonly classified with it, we are told that it is a monosyllabic language, "incapable of composition and consequently without organism, without grammar" (Bopp., V. G., s. 108, and A. W. v. Schlegel, ibid.). In other words we are taught to believe that it is altogether like those one-syllable stories which are considerately placed before the eyes of the child, when it takes its first lessons in reading. Unfortunately our knowledge of Chinese was first obtained through a medium which produced much distortion. The distance of the country and the opposition of Chinese authorities to all intercourse with foreigners, were serious obstacles to the attainment of accurate information. Many of our Chinese scholars made their studies of the language at Singapore instead of China; and of those who have had opportunities for a nearer view, too many have found, even at Macao, but very imperfect means of mingling with educated natives. Again, what we commonly call Chinese seems to stand to the languages generally spoken in that country, much as Latin did a few centuries ago to the vulgar tongue of Italy or France. In other words it is rather a dead than a living tongue. But there has been a still greater hindrance in the channel through which Chinese is studied. Our scholars have learnt it, as scholars always love to do, through books, rather than by oral communication. Thus, they have allowed themselves to be led astray by what is merely an accident of the written language. The characters being monosyllabic, they have hastily assumed the language to be the same; and thus Europeans commonly believe that the Chinese have been contented with a form of speech which, by its mere monotony, would have dispirited any other race of beings; while some have thought that this painful monotony may be, in native practice, partially corrected by the mysterious influence of the so-called four tones. Such views are upset by the simple testimony of one who had the best opportunities of obtaining exact knowledge, the late English consul at Ningpo, Mr. Robert Thom. From him we learn that the Chinese, like our own tongue, though rich in monosyllabic words, has no scarcity of disyllables and polysyllables. In the preface to his 'Chinese Speaker' (Part. 1, Ningpo, 1846,) he directs one who would learn the language to try to get an intelligent native of Pekin to read the Chinese and to follow him on the English side of the page (that is the side with the Chinese written in English characters, and having an interlinear English translation) "as a clerk follows the parson in church;" and he goes on to say, that such a student "cannot fail to observe, as he reads along, that many words are disyllables and not a few polysyllables; that some are accented on the ultimate, others on the penult, and others again on the antepenult, &c." Indeed Mr. Thom was prevented from marking the said accents solely by the paucity of accentuated letters at his command. A short example from his book may be of use:—

Yĭh-ko-jin	heŏ	Kwan-hwa lai	tso shim-mo-tĭ ne?
Now-a-man	in learning	the Mandarine language	what is his object?

Those who deny to the Chinese a grammar, seem to have started with wrong notions of what grammar is in their own language, and on that account alone have failed to find in Chinese that of which they were in search. The merest inspection of a Chinese grammar tells us that a certain syllable *tći*, or in Mandarine more commonly *tĭ*, affixed to a substantive, serves to express the relation which Europeans denote by the term "genitive case," that another syllable, *tu* for example, added may imply plurality, and so on with the other secondary notions of grammar. Thus *uĕ-tći sing*, "the origin of things," *Wen-vvang-tći tĕ-tći shun*, "the purity of the virtue of the Wen-vvang," or more literally, for the Chinese genitive always precedes, "the Wen-vvang's virtue's purity," *tĕ* denoting "virtue," and *shun*, "purity." So again, *ǵin* is "a man," *ǵin-tu*, "men." It is also true that at times the mere proximity of two words is sufficient to express a relation between them without the formal employment of a special particle. So with us, the nominative and accusative are sufficiently pointed out by their mere position, whereas in Greek and Latin, a suitable affix is required for the office. So again we say *moonlight*, when we mean the "moon's light." But it may by some be thought detrimental to what is here said, that the syllables which the Chinese employ as affixes, have an original meaning of their own; for example, that the particle commonly used, as above said, to denote the genitival relation, is at times employed as a verb equivalent to the Latin *proficisci*, in other words, with the sense of "departure." But here we have only a proof that the Chinese grammar is less corrupted, purer, more simple, than our own; and we may further appeal to this instance in support of the doctrine, that all affixes were in origin themselves roots. It may also be noted that the omission of the genitival suffix, though common in ordinary Chinese, occurs most rarely ("fast niemals," says Endlicher) in the Mandarine dialect. In truth, the further we trace a language back, the more certain are we to find the suffixes expressed, as in *Πελοποννησος*, which is but a corruption of *Πελοπος-νησος*. Thus in the German *mond-en-licht*, the middle syllable may well be regarded as virtually a genitival suffix, a better theory surely than that which regards it as a euphonic insertion.

But while we would ascribe the false theory of the monosyllabic character of Chinese to the fact of our approaching the language through its syllabarium, so we have the converse error in the habit of attributing a specially polysyllabic or polysynthetic character to Basque and the languages of North America. Here there is, or rather was, no written language, and the traveller had no choice but to take down what a native spoke, as he spoke it, and of course with many of what we usually regard as separate words, all jumbled together in one confused mass. We need search for no better example than the polysyllabic term employed by the Aztecks in addressing a priest, as given under this word in the GEOGRAPHICAL DIVISION of this Cyclopædia. Shakspere, and the inhabitants of Iceland, use for this purpose, the sufficiently short term, "Sir," but the Mexican layman addressed the priest as *notlazomahuizteopixcatâtzin*, which, being interpreted by Clavigero, amounted to: *no*, "my," *tlazontli*, "esteemed," *mahuiztic*, "revered," *teo-pixqui*, "god-keeper," *tatli*, "father."

But the most formidable exception to this asserted law of monosyllabic roots is seen in the Semitic family, especially the Arabic and Hebrew, where it is maintained that all ultimate words are of two syllables, and contain three consonants. Nay, some continental scholars of the present day, carry their theory of Hebrew roots to the extreme point of denying it the possession of any vowel, so that *ktl*, according to them, is the root of the class of words signifying "kill." Such theorists seem to forget that spoken language has a priority over written language, for surely if they would picture to themselves the time when Hebrew was not yet written, they would find themselves in a "reductio ad absurdum," when declaring that to be a root which is confessedly unpronounceable. No doubt in Hebrew, as we now have it, the vowels are very variable, so that for example, we find *kôtêl* denotes "killing," and *kâtûl*, "killed." The Greeks too have such varieties as *νεμω*, *νομος*, *νωμαω*; but this has not induced our classical scholars to exhibit the root of this series of words as *νμ*. As to the variation of vowels within the limits of a root word, some remarks will presently be made; but to the doctrine that the roots of the Hebrew were originally disyllabic, we may oppose the strong belief of some of the ablest Hebrew scholars that this appearance is due solely to the fact, that secondary forms have supplanted the original simple stems. Similarly in our language *bellow*, *reckon*, *listen*, *begin*, *wallow*, have pretty well usurped the places of the obsolete verbs, *bell*, *reck*, *list*, *gin*, *wall*; and similarly in Latin, *sona-re*, *tona-re*, *lava-re*, *senti-re*, *cense-re*, *meti-ri*, might have passed for simple verbs, had not some of the older writers preserved for us such form as *son-ere*, *ton-imus*, *lav-ere*, while the existence at an early date of such verbal bases as *cen-* "puncture," "counting by prick of pin," *sen-* "feel," *men-* "measure," is established by derivatives, as *cen-sus*, sb., *cen-trum*, the Homeric *ε-κεν-σα*; by the perf. *sen-si*, *sen-sus*, sb., *sen-sim*, *sen-tis*, sb.; and by *mensus*, *mensor*, *mensura*, and *mēta* (that is, *men-ta*), "a mile-stone," so to say. But perhaps the most instructive example of disyllabic verbs simulating primary verbs, occurs in Hindostani, where the native grammarians lay it down as a general law that the simplest verbs, as in Hebrew, are disyllabic; yet the modern character of such a formation is at once established by the consideration that the great body of this language has descended from the Sanskrit, in which the monosyllabic form of primary verbs is undisputed.

The change of vowel in *kôtêl* and *kâtûl* belongs to a question which may be more conveniently considered presently, when the law of assimilated vowels comes under consideration.

But it is not uncommon for philologers to imagine to themselves a distinction between what they are pleased to call synthetical and analytical languages. Thus they would contrast the habit of some languages to express secondary ideas by affixes, as *patris*, *patrem*, *scribo*, *scribis*, *scribam*, *scripsi*, &c., with others, especially of modern date, which prefer to employ prepositions or formal pronouns in the nominative or auxiliary verbs; but it will be seen in the sequel that there is no substantial distinction between a case-ending and a preposition, that auxiliary verbs are employed in those affixes which belong to perfect tenses, and that the final letters of *scribo*, *scribis*, are as completely pronouns in origin as the *I* and *you* which an Englishman prefixes to his verb. The real distinction is, that in the one case the little words precede, in the others follow, unless indeed any stress be laid upon the corrupted form which often characterises affixes. Yet even here the distinction is not very marked, the letters *bi* in *ibi*, *alibi*, *nobis*, *vobis*, being as fully pronounced as our own *by*, the *o* of *scribo* scarcely more abbreviated than our own *I*, while *I'm afraid*, *I've done*, *I'll tell him*, *I'd like to know*, have cut down the verbs *am*, *have*, *will*, *would*, as far as possible short of annihilation. But take such a case of contrast as *he did love* compared with *he loved*. When we trace the latter form upward, we find in the Anglo-Saxon *he lovede*; and if we ascend a step higher in the history of our language, so as to enter the domain of the Gothic, the oldest specimen of the German family, we find good evidence that such a form as *loveded* existed, but of course with the regular personal endings, which belong to the Gothic preterite, attached. (Grimm's 'Gr.,' i. 840.) Thus the contrast is reduced to *he love-ded* as opposed to *he did love*; in other words, we have but a different arrangement of the same elements.

In all cases, no doubt, were our means of inquiry equally abundant, we should be brought to the conclusion that the formation of derivatives is but the agglutination of significant syllables to significant syllables, or, in simpler language, of roots to roots. This assertion is founded on various considerations: first, the mere fact that in a large and rapidly increasing number of examples what were unintelligible affixes have received their due explanation; secondly, the *à priori* argument, already employed to show that roots obtained their significancy not by arbitrary compact, but by natural association; and, thirdly, the consideration that as affixes are attached to the end of words, and also sustain for the time an inferior office, they are doubly liable to a careless—in other words, shortened—pronunciation. On ship-board, for example, time is often of the first moment. Thus, when the writer once heard the French steersman of a French boat give orders to a "mousse" for dropping the foresail, in the words "Down with her," unconsciously speaking English, his inquiry as to the use of these words was met by the remark that "Faites-le-descendre" would be too long. No wonder, then, that sounds such as *bosen* and *foxel* should be preferred to *boatswain* and *forecastle*. Again, our own word *wanton*, at first sight of sufficiently obscure formation, has been analysed as representing *wan-tow-en*, "ill brought-up," where *wan* is the prefix seen in the old English *wan-hope*, "mala spes," and still abundantly flourishing in the Dutch language; while *tow-en* is the old participle of the verb *tow*, the equivalent of the German *zieh*-en and Latin *duc*-ere; so that *wanton* is substantially the same as the German *ungezogen*, "uneducated, untrained." Our term *workhouse* is self-explained; but this word is beginning to obscure the second element when pronounced as *workhus*. Again, take our word *mum* or *ma'am*—who beforehand would have supposed that the final liquid in this word represented the Latin word *domina*, as is the fact: *mea domina*, *madonna*, *madame*, *ma'am*, *mum*, and in one of Dickens's novels, *mim*.

Here we have seen the second part of the word shorn of its fair proportions. The blow may however fall on the prefix. Thus, *ανα*, of the Greek language, when used before verbs, was reduced in the Æolian and Doric dialects to *αν* and *ον*, and under special circumstances to a mere *α* or *ο*. No wonder, then, that the Latin *a-gnosc-ere* exhibits the same prefix as a mere vowel, or that the A. S. *on-cnaw-an*, and Shaksperian *a-cknow* (part. *acknown*, 'Othello,' iii. 3), as well as our existing *a-cknow-ledge*, have taken similar liberties. A still more violent corruption of what might be proved to be the same pronoun is seen in our *e-lope*, which represents the German *ent-lauf-en*, Dutch *ont-loop-en*. Cases even occur where the original root is wholly absorbed in some derived form. Thus, as Bopp has noticed, the German *im*, corrupted from *in-de-m*, has preserved the preposition and the case-ending, but wholly lost that to which they were at first attached, the element *de* (our *the*). Another example of similar extreme violence has been seen in *I'd* for *I would*, the essential syllable *wol* of the verb having utterly disappeared. As compression, then, is a very common occurrence in language, it behoves an inquirer not hastily to assume the radical character of all monosyllabic verbs. If he find two consonants either commencing or terminating the syllable, the strong probability is that a really disyllabic word is before him. Thus, *know*, *pluck* (*ck* is but one consonant), *culm*, *hulk*, should be regarded as corruptions of some such form as *ken-ow* or *con-ow*, *pul-uck*, *cul-um*, *hul-uck* or *hul-ock*, and so only secondary formations from the simple *ken* or *con*, *pull*, *coal*, *hull*. Nay, in many cases where the initial consonant is a simple *r*, *l*, or *n*, a truncation of the commencing letters may be suspected. For example, the Latin *nosc-ere* is historically known to be a corruption of *gnosc-ere*, where the first syllable represents our *know*, and thus *gen* or *gon*, corresponding to our *ken* or *con*, is the base. The related Greek *ονομα* has preserved the radical vowel, and only lost the guttural. So, again, when our *laugh* (Germ. *lach*-eln) is placed beside the Greek *γελα-ειν*, *γελακ-σω* (*γελαξω*, Doric fut.), we see that the base of the words is *gel*. For an example of a deceitful *r*, we may quote our verb *run*, which in the Dorset dialect is *hirn*, and here the *n* is but the remnant of a common suffix, as seen in *op-en*, *heark-en*, *burn*, *mourn*, *turn*. The base, then, is *hir*, corresponding to the Latin *cur* of *curro*, the interchange of *h* and *c* being the law between these languages.

In the formation of secondary words, by such agglutinations as we have spoken of, due attention must be paid to those very natural laws which require an adaptation of discordant elements, a subject treated in all its integrity in Sanskrit grammars, under the title *Sandhi*, "composition." The main principles are the same for all languages. Thus, when medial or thick consonants, so to say, are brought into contact with thin consonants, the one or other must change its character. For example, in Greek you may prefer the thin consonant and say *ἑπτα*, *οκτω*, or you may prefer the thick and say *εβδομος*, *ογδοος*; but adaptation, at any rate for the voice, is required. So again labials and dentals refuse to coalesce. A German says *lende*, 'loins,' a Roman said *lumbi*; in Greek we have *ανα-δευ-ειν*, or for an Æolian *αυ-δευ-ειν*, "to wet for the first time;" in Latin *im-bu-ere* is preferred. But the most important, yet most neglected, law of assimilation in the composition of words, is that which concerns the vowels. No doubt the Sanscrit grammarian dwells at sufficient length, on the effect produced by the contact of two vowels, as when he tells us that the meeting of a final *a* with an initial *i* leads to the substitution of the intermediate vowel *e*, and similarly that the junction of *a* with *u* produces the intermediate vowel *o*. But a far more material point is the adaptation of vowels, more or less, when they are separated by consonants. In all dealings with vowels, whether in this Sanscrit habit of combining *a* and *i* into *e*, or *a* and *u* into *o*, or in the larger question now opened, the main guide of the philologer is the vowel law, established by the experiments of Professor Willis, namely,—that the kind of vowel-sound produced by the vibration of a reed, depends solely on the length of the tube that intervenes between the reed and the point of opening into the outer air; and that, as the reed is lengthened, we have a succession of sounds in the same invariable order, *i*, *e*, *a*, *o*, *u*, as pronounced by an Italian, not that the sound jumps from one of them to the next, but passes by imperceptible degrees through other sounds intermediate between them, which our alphabet is utterly unequal to denote, and indeed no alphabet could in perfection. But for the full comprehension of the question, the paper, or rather two papers, should be read *in extenso*, as given in the Transactions of the Cambridge Philosophical Society for Nov. 24, 1828, and March 16, 1829. Now as the character of the vowel depends, for the human voice, solely on the distance between the *chordæ vocales* in the *larynx*, which act as the musical reed, and the margin of the lips, and is otherwise in no way dependent on the form taken by the organs of speech; and as on the other hand the character of the consonants depends solely on the form and relative position for the time of these organs, the length of the vocal tube being immaterial, it follows that it is an easier matter to produce the sound of a polysyllable, all the vowels of which are the same or similar; and in this, as in all the labours of man, the saving of trouble is a paramount consideration. Hence, in savage nations, the abundant supply of such geographical terms as *Mississippi*, *Tennessee*, *Alabama*, *Oronoco*, in America, or of *Kamtchatka*, *Japan*, *Palawan*, *Sarawak*, *Sambawa*, *Samarang*, *Balambangan*, *Banca*, *Java*, *Malacca*, *Andaman*, *Madagascar*, *Loochoo*, *Siou-siou*, *Sooloo*, *Comoro*, &c., in Asia. Hence too in the formation of secondary words there is a constant tendency to assimilate the vowels of united syllables, when they happen to be discordant. This may be effected in several ways, by the adaptation of the first vowel to that which follows or the converse, or thirdly by an approach of one or both to some intermediate sound. It is commonly by a modification of the first syllable that the object is attained in the German, Scandinavian, and Keltic languages, and so far as the principle prevails in Greek and Latin, all of which are members of the great Indo-European family. On the other hand, in the languages of Tartary, Turkey, and Hungary, as well as those in northern Europe and Asia, spoken by the Finns, Lapps, &c., it is the suffixed syllable that is compelled to take a vowel more or less similar to the vowel of the preceding syllable. Hence, in languages of this class, for all that have been just enumerated belong to one family, we find suffixes to a great extent running in pairs, which, with a common power, have no other difference in form than the interchange of a strong and weak vowel. Thus, in Turkish, *kalpak*, a cap, has nom. pl. *kalpak-lar*: but *év*, a house, has a nom. pl. *év-ler*; and again the datives pl. of these nouns are respectively *kalpak-lar-ah* and *évler-eh*. Or, to take an example from the Hungarian, the verbs *vár*, "wait," and *ismer*, "know," form the following persons:—

varok, I wait.	**ismerek, I know.**
várunk, we wait.	**ismerünk, we know.**
vártok, ye wait.	**ismertek, ye know.**
várnak, they wait.	**ismernek, they know.**
váratok, ye waited.	**ismerétek, ye knew.**

Nay to such an extent is this law of assimilation carried out in the Mongolian, that it is turned to account in economising the number of alphabetical characters. As the first occurring vowel decides the character of those that follow, a common symbol is used in all syllables after the first for *a* and *e*, a second common symbol for *o* and *ŏ*.

But in the other division of languages, as was just said, it is the first syllable that adapts itself to those which follow. If we look to the German languages, the familiar modification called "umlaut" is for the most part made in the direction of exchanging strong for weaker vowels. Thus *a*, *o*, *u*, if followed by a syllable containing either *i* or *e*, are apt to become ä, ö, ü respectively, where the two dots represent, and indeed have grown out of, an *e*, and *ae*, *oe*, *ue*, severally denote sounds weaker than those which they displace. One of the most interesting cases of the *umlaut* to be found in German, is seen in the second and third persons of many so-called irregular verbs, as *schlaf-en* "to sleep," *du schläfest*, *er schläft*; *stoss-en*, "to push," *du stössest*, *er stösst*. But it may be asked why the same modification is not found in the other persons, *ich schlafe*, *wir schlafen*, &c., and the answer is only to be found in the formation of the old German, where the suffixes of the several persons are: 1.—*u*, 2.—*is*, 3.—*it*; pl. 1.—*ames*; 2.—*at*, 3.—*ant*; so that the only persons which by the weak vowel of their suffixes were originally entitled to the influence, are precisely those for which it is claimed. But it is not merely the *a*, *o*, *u*, which are subject to the influence of the *umlaut*; to the same cause must be attributed the modification which occurs in the second and third persons of *brechen*, "to break," whence *du brichst*, *er bricht*; *essen*, "to eat," *du issest*, *er isst*; *geschehen*, "to happen," *es geschieht*.

But while the weakening of stronger vowels is the phenomenon so common in German, the Norse, over and above this, abounds in examples of the converse action. Thus *kalla*, "to call," has *köllum*, "we call," where *ŏ* has a sound more nearly akin to *u* than to *o* itself. Again, *drecka*, "to drink," has a past tense sing. *drack*, pl. *druckum*, while the subjunctive is *drycki*. Similarly *dŏr*, "a spear," has in the pl.: n. *derir*, ac. *deri*, dat. *dŏrum*, gen. *darra*. Nay the influence of the added suffix often extends over two syllables. Thus from the same verb, *kalla*, is deduced a past tense, which in the singular has for its first two syllables *kallað*; but taking a *u* in the three suffixes of the plural, presents us with þer *kölluðum*, þer *kölluðuð*, þeir *kölluðu*. Similarly among the adjectives, the form *hagast*, "most handy," *annar* (= Lat *alter*), have for the dat. pl. *högustum*, *öðrum*. Still more effective is the attraction in *ketil*, a "kettle," which has pl.: n. *katlar*, ac. *katla*, dat. *köllum*, gen. *katla*.

In the Keltic family the following examples of modified plurals are taken from the Breton: *baz* "stick," *bizier*; *taro*, "bull," *tirvi*; *falch*, "scythe," *filchier*; *mab*, "son," *mipien*; *dred*, "starling," *dridi*; *lestr*, "boat," *listri*; and even with the influence extending through two syllables: *kalvez*, "carpenter," *kilvizien*; *ênez*, "island," *inizi*. In some of the examples the suffix of plurality, whether it was *en* or *er*, after effecting the modification of the previous vowel, is itself dropped; no doubt because the modification itself gave a sort of notice that the plural suffix was about to appear, and so by anticipation rendered that suffix superfluous, the consequence being that, what was thus useless, was dropt. Similarly we find *dant*, "tooth," pl. *dent*; *oan*, "lamb," *ein*; *dañvad*, "sheep," *deñved*; *abostol*, "apostle," *æbestel*; *azrouand*, "devil," *ezrevend*; *escob*, "bishop," *esquebyen*, or *esqeb*. The Breton verb is even more instructive in respect of this law. Thus *gall-out*, "to be able" (*val-ere*), has for its future: 1. *gellinn* or *gillinn*; 2. *gelli* or *gilli*; 3. *gallô* or *gellô*; pl. 1. *gellimp* or *gillimp*; 2. *gallot* or *gellot*; 3. *gelliñt* or *gilliñt*—where it may be observed that *gell* has to contend with a rival, *gill*, whenever the weak *i* follows, and with *gall* before a suffix containing a strong *o*. In the verb *lavar-out*, "to say," the assimilation runs through two syllables, as *lavarann*, "I say;" *leverez*, "thou sayst;" *livirit*, "ye say." It should be added that when the vowel thus subjected to "umlaut" is *ou* (*u*, *oo*), a trace of the *oo* sound is preserved by the substitution of *we*. Thus from *gouzout*, "to know," comes a future, *gwez-inn*. In English the principle has a more extensive sway than is commonly supposed. A few examples are: *old*, *elder*; *good* (Germ. *gut*), *better* (for *gwetter*—cf. *gwezinn*, just dealt with); *cat*, *kitten*; *foal*, *filly*; *one*, *any*; *fox*, *vixen*; *shake*, *shiver*; *quake*, *quiver*; *pray*, *prythee*; *cock*, *chicken*; *Jane*, *Jenny*; *Kate*, *Kitty*. And not unfrequently the modification extends beyond what the written form denotes, as in Greenwich; grass, grazier; one, any; brother, English, women. In our plurals, such as *geese*, *feet*, *women*, we have what was just seen in the Breton, the modification of the root vowel (of *goose*, &c.) by the weak vowel of a plural suffix, and then the loss of that suffix.

We may occasionally trace the action of the same principle in the classical languages, as *νομο*-(n. *νομος*) and *νεμεσ*-(n. *νεμος*), from the verb *νεμ-ειν*; *γονο*-(n. *γονος*) and *γενεσν*-(n. *γενος*), from *γε* of *γιγνειν*; *στρωφα*- and *νωμα*-, as secondary verbs, from *στρεφ*- and *νεμ*-, while in *οροφο*- beside the verb *ερεφ*-, we see two syllables subjected to the influence. For Latin we may quote *bene* beside *bonus*; *velim*, *vellem*, *velle* beside *volo*, *volam*, *volunt*; and in the conjugation of the verb *i*- "go" and the pronoun *i*- (n. *is*) the law holds that whenever the following vowel is *a*, *o*, or *u*, the *i* of the base gives way to the stronger vowel *e*, as *eam*, *eo*, *eunt* for the verb, *ea*, *eo*, *eum* for the pronoun. The instances now quoted are few, but must not be taken as in any way a fair measure of the extent to which the law of vocal assimilation holds in Greek and Latin. Other examples will follow, and more be hinted at.

The principles which have been enounced, of consonantal and vowel assimilation, together with the general doctrine that man endeavours to lessen the labour of speech by every species of curtailment and abbreviation, are not sufficient to explain the anomalies of word formation. We must further allow for the interchange of convertible letters, on which subject we may refer to the article ALPHABET, where the general relations of the letters to each other are considered, and to the separate articles on the individual letters. But it is scarcely more important to lay down true principles than to guard an inquirer against prevailing fallacies. No field more abounds in weeds of this character than the learned pages devoted to the subject of the so-called grammatical figures. To such of them as denote the loss of letters, whether initial, internal, or final, the only objection is, that they are often thought to carry with them an explanation, whereas their only use can be to serve as labels for a given class of changes. But all those pseudo-learned terms which are so freely used by philologers to account for letters and syllables whose presence they cannot explain, are unqualified nuisances, the removal of which can only be beneficial to the science. Such are all those which assume the addition of letters or syllables which are confessedly of no meaning, and so only add to the labour of utterance, as *prosthesis*, *epenthesis*, and *paragoge*. They are habitually called in to explain the older and fuller forms of language, on the strange assumption that the later, and for that reason more common, and at the same time more corrupt, varieties are the genuine words. In truth, when a word occurs in two forms it may be assumed, *à priori*, that the fuller is the older, if only because the loss of letters is explained by man's general tendency to abridge his labours; while to the doctrine of added or inserted letters there is always opposed the difficulty of answering the question, why one letter rather than another was selected. This objection especially applies to those cases where a consonant is said to be inserted between two vowels for the sake of avoiding the disagreeable proximity of vowels, *hiatus vitandi causa*. There is also the standing objection in all such cases, why does the speaker add unnecessarily to his labour of speech? But these general arguments, grounded on theory, are constantly receiving fresh confirmation from the results of historical inquiry in particular cases. The phrases, "for the *n*once," "the *t*one, the *t*other," are now explained by the fact that the pronoun *the* had older forms, *then* and *thet*, the final consonants of which have been unduly ascribed to the following word. It seems too not improbable, that the forms *nuncle*, *Nan*, *Ned*, &c., owe their first letter to a similar theft from the pronoun *mine*, as though *mine uncle* was erroneously divided into *my nuncle*. In the contest between the claims of *a newt* and *an eft*, it may be difficult to come to a just decision, but "epenthesis" is wholly out of the question. That *an* rather than *a* is the earlier form of our so-called article is now generally admitted, and equally so that the familiar *a* privative of the Greek language is but a corruption of an older *αν*. Similarly, *εστιν*, *ετυψεν* (for *ετυψετ*), *λεγουσιν*, *λογοισιν*, are the more genuine forms, which a careless pronunciation reduced to *εστι*, *ετυψε*, *λεγουσι*, *λογοισι*, and ultimately *λογοις*. But perhaps the most amusing instance of inverting the order of time is the explanation, still often met with, that the *archaic* infinitive of the Latin, such as *mirarier*, is to be deduced from the *late* form *mirari* by the addition of a meaningless *er*. As regards the *t* which appears as an intruder in the French *aime-t-il*, a moment's thought will show that it is but the final letter of an older *aimet* for the Latin *amat*; and similarly, to quote a parallel case, though the *t* is silent in *il est vrai*, it assumes its full power in *est-il-vrai?* But if these are matters now admitted, there still prevails the practice of treating many initial vowels as added for the sake of euphony. Thus the words *ονομα*, *ελαχυς*, *ορυσσω*, *αρασσω*, when fully examined, will be found to have in the syllables *ον*, *ελ*, *ορ*, *αρ*, at any rate a portion, it may be the whole, of the radical element. In the case of *ονομα* it is demonstrable that an initial *γ* has been lost, the change being similar to that from *κανθραξ* to *ανθραξ*, *καπρος* to *aper*, *κολαφος* to *alapa*. In *ορ-υσσ-ω* and *αρ-ασσ-ω* the syllables *υσσ* and *ασσ* are no more radical than in *αιθ-υσσ-ω* and *μαλ-ασσ-ω*; while the syllable *ελ*, in the sense of "little," is familiar in all the branches of the Indo-European family, and not the more to be despised because it commonly occupies the less important position of a suffix. Moreover it is a fact productive of suspicion, that the said euphonic vowel is usually claimed in cases where the next adjoining consonant is a liquid, especially one of the three, *r*, *l*, *n*, which, as above noticed, are constantly putting forward false claims to the initial place in a root. It will not, however, be at variance with the principles here expressed, if it be admitted that on the importation of a foreign word commencing with two consonants difficult of pronunciation, an initial vowel is naturally prefixed to aid pronunciation. In such cases as the French nom*b*re, com*b*le, gen*d*re, ven*d*redi, or the German wochen*t*lich, the letters *b*, *d*, and *t* are no way insertions of foreign matter; they serve merely as notes that the preceding liquid must be pronounced with special distinctness to save them from absorption under the influence of the following *r* or *l*; for whenever we produce an *m* or *n* with unusual pressure of the organs, we have forthwith before us what is better denoted by *mb* and *nd*. It is on this principle that our own language has the words *hand*, *sound*, and in the vulgar tongue *gownd*, in place of the simple *n* of *manus*, *sonus*, and *gown*.

The use of the grammatical terms *tmesis* and *diaeresis* is also an act of anachronism. While it is the ordinary law of language to agglutinate independent words, and to crush adjoining vowels together, no doubt at times a poet may find it convenient to avail himself of earlier obsolete forms which were in use before such agglutination or crushing had taken place. But to treat Ατρεΐδης as deduced from Ατρειδης and call the process *diaeresis*, or to call it *tmesis*, when the old poet himself, before the agglutination of a preposition to a verb was yet effected, wrote *ἥμιν απο λοιγον αμυναι*, or when Herodotus under like circumstances, wrote *απο μεν εθανε ὁ στρατηγος*—this is simple perversity.

Again a large amount of unsound philology is concealed under the term metathesis. Although no doubt there occur instances where a letter shifts its position in a word either through error in the person who repeats it, or by a sort of involuntary stuttering, as, for example, in the French *frange*, Eng. *fringe*, from the Latin *fimbria*, as though it had been *frimbia*. The interchange of *sk* with *ks* is no doubt common in language, but here the real explanation is probably that for the ears of many people the sounds *s*, or perhaps *sh*, and *k* or *g*, are so akin as to be readily interchangeable; and thus we have had in this island the names *frosc*, *frox*, *frosh*, and *frog*, all applied to the same reptile; and this interchange would naturally carry with it the interchange of *sp* and *ps* in those countries where a *k* is supplanted by a *p*. Similarly when a Spaniard substitutes *milagro* for the Latin *miraculo*, the substitution of *l* for *r*, which occurs in the first syllable, was for him a change of the faintest character, and this change once made encouraged the converse change in the third syllable. This however is no metathesis. As the erroneous doctrine here combated has established itself only too firmly among philologers, it is the more important to point out the cause which has led to the error. No doubt abundant instances can be found like *durch*, Germ., and our *through*, *θρασος* and *θαρσος*; *tero*, *trivi*. Here there is an apparent passage of the vowel from one side of the liquid to the other; but it is only apparent, the truth being that in all such cases the older form was possessed of both vowels. For the first pair of words just quoted, we still have the full form *thorough*; and the truth is that the word consists of two elements *thor*, "a door," and a diminutive suffix *ough*. Θαρσος and *θρασος* are to be explained as alike corruptions of a fuller *θαρ-ασ-ος*, in which *θαρ* represents the chief element, being the equivalent of our *dare*, according to the usual law that holds between the languages of a *θ* and *d* corresponding. The second syllable *ασ* is that so commonly found in secondary verbs of the Greek language, as *ταρ-ασσω*, *αρ-ασσω*. The case of *tero* beside *trivi* and *tritum* is explained by the Greek *τριβ-ω*, and better still by the Latin *ter-eb-ra*, where the base is *ter*, *eb* a suffix, seen also in *frem-eb-undus*, *gem-eb-undus*; which it is the less necessary to dwell on here as it will come under consideration again. What has tended to encourage the leap-frog doctrine here assailed, is the strange coincidence, as it may well appear, that the vowels should so generally be the same. The answer is to be found in the law above-mentioned, that in the composition of words there is ever a strong tendency to bring discordant vowels into harmony. Thus the Greek verbs *ταρ-ασσ-ω*, *ερ-εσσ-ω*, *ειλ-ισσ-ω*, *ορ-υσσ-ω*, have in truth a common suffix, which takes the several varieties of vowel to please the preceding syllable. Another interesting case of the same principle is seen in the series of words, all one in origin: *παλλακ-* "a young man.' Lat. *pellec-* "a young woman," a euphuism for a concubine, Eng. *fillie* "a young mare;" *πωλο-* "a foal," Scotch *pollock* "a young fish or crab," *pullo-* (nom. *pullus*) "a foal" or "a chicken,"—where the first syllable seems to denote "young," and the suffix is of diminutival power, so that the words in themselves merely signify "a little young one."

The other figures, such as *aphæresis* "the cutting off the head of a word," *syncope* "the compression of the interior of a word," *apocope* "the cutting off the tail of a word," together with the terms *crasis* *synaloephe* and *synæresis*, which deal with the compression of adjoining vowels, tell no untruth, and so may be left to the use of those who have an affection for hard words. The one general principle under which they fall, and this alone is of moment, is, that words are ever subject to diminution. No doubt false analogies may occasionally lead to a violation of this general principle. Thus our *island* and *sovereign*, as now written, have letters in them to which they are no way entitled, through a mistaken reference of them to the old French *isle* (*île*), and the word *reign* or *regnum*. A more justifiable form would have been *iland* (like the German *ei-land*), and *sovran* (Ital. *sovrano*).

To trace language through all its varieties of declination, conjugation, &c., would far exceed our fitting limits. Some two or three questions of leading moment can alone be considered, and we may justly give a precedence to the doctrine of diminutives on various grounds. They play an important part in the formation of verbs, substantives, and adjectives alike; once formed, they are apt to usurp the place of the primitive, and so cause the utter disappearance of that primitive; and by a natural consequence, when thus acting the part of primitives, they suggest occasion for the formation of new diminutives. Nay, this process is sometimes repeated again and again; and we may even venture to say that a large per-centage of language is made up of diminutival elements. As examples of diminutives wholly supplanting primitives we may quote the Italian *fratello* and *sorella*, the only terms in that language for brother and sister; the French *soleil* and *hameau*; the English *weas-el* (Scotch *ware*), *stocking* (Shakspere *stock*, as "With a linen *stock* on one leg, and a kersey boot-hose on the other." 'Taming of the Shrew,' iii. 2), *wander*, and *learn*; the German *esel*, *ferkel*, and *schenkel*; the Latin *oculus* and *spargere*; the Greek *δακτυλος* and *κεφαλη*—in all which cases we must pass over into cognate languages, or search for obsolete forms, before we find evidence of the simple words from which they have been deduced. Another inconvenience arises from the variety of form which even the same suffix takes, a variety the less surprising, because the affix being often of no practical value is for that reason more carelessly pronounced. In our Indo-European stock the diminutival suffixes may perhaps be reduced to two original elements, *el*, and something like *ach* or *och*. But the *el*, as regards its consonant, easily slips into *er* on the one hand, *en* or *em* on the other; and by an easy change of the vowel the Latin employs *ul*, and *in* or *im*, rather than *el* or *en*; while the Greek seems often to give a preference to an *a*, as in *μεγαλη*, *μηχανη*, *κυαμος*. The element *agh* or *ach* is, however, the more fertile suffix, and its varieties are all but endless. In the Gaelic (and we purposely quote from one of the languages which have preserved more readily the guttural varieties we find an abundance of forms, such as *curach*, "a wicker-boat," or "coracle;" *beach*, "a bee;" *camag*, "a curl;" while the English, especially if we include in our view Lowland Scotch, supply a list far exceeding the meagre limits of those quoted by Grimm. We have room only for *bittock, bullock, charlock, fistock, haddock, hassock, hillock, laverock, pellock or pollock, tussock.* The Scotch again gives us the clearest evidence of the tendency in this suffix to modify alike its consonant and vowel. Thus, the word *haddock* has in some localities given way to *haddow*, and elsewhere to both *haddick* and *haddie;* and the last of these suffixes, happening to have met with a general preference in the parts about Edinburgh, that is, in the domain of letters, has, as might have been expected, secured a great preponderance to such forms as *lassie, laddie*, or, as we now write them in the south, *lassy, laddy*. The Slavic and Gaelic itself may also be called, to show how readily a final guttural vanishes. Thus, *batach*, "a little boat," *pòcach*, "a little pocket," have *batach-an, pòcach-an*, in the plural, but only *bata, pòca*, in the singular. The old Slavic, again, has a number of words ending like *πραχ*, "dust," *μιεχ*, "leathern-bag," *κοζυχ*, "skin;" but in the later languages, Servian for example, the guttural has been rubbed off, and left us *πρα, μηιε, κοζυ* (where we employ the Greek character as more readily intelligible to English readers); so also we ourselves have done well to prefer *way, hay, honey*, to *weg, tag, honig*, of the German. The classical languages have also the same suffix, as, for example, *ῥοδαξ*, "a dwarf rose," *λιθαξ*, "a small stone," *σπαλαξ*, "a mole," *παλλαξ*, "a youth," *ὑραξ*, "a shrew-mouse" (over 60 might be given); in Latin, *limax*, but commonly with a variety of vowel, as *podex, silex, culex, pulex, cimex, apex, carex, sorex* (35); *radix, calix, salix, filix, fulix, larix, varix, struix* (25). In *ονυξ, crux*, and *fruges*, the *u* has been preferred; and compression has destroyed all trace of the vowel in *arx, calx, falx, lanx, merx*, as it has also done in our own *lark* (*laverock*), *park* (Anglo Saxon *parruc*). The list is already tolerably large, but over and above the quotations just given from the third declension, we must also claim the great mass of the other or vowel declensions. We have already seen how a final guttural was lost in some northern languages, so in Latin, the adjectives *rosac-eus, violac-eus, testaceus* (24), compared with *lapid-eus*, tell us that *rosa, viola*, and *testa*, have suffered a similar curtailment; *aprug-nus* tells us the same for *apero* (nom. *aper*), *murtac-eus, hordeac-eus, sebac-eus* (21), *rapic-ius, tribunic-ius*, &c., for *murtus, hordeum, sebum, rapum, tribunus. Ensic-ulus, canic-ula, retic-ulum, genuc-ulum* (aft. *genic-ulum*), *metūc-ul-osus* (aft. *meticulosus*), *cornic-ulum; diec-ula, rec-ula*, severally claim a final guttural for the nouns whose nominatives are *ensi-s, cani-s, rete, genu, metu-s, cornu, die-s, re-s.*

But as the aspirated guttural among ourselves has often passed into a labial, as witness, *laugh, rough, cough*, so we find our diminutive in *fl-uff*, and with loss of the vowel, *cal-f, hal-f, tur-f* (Scotch, *toor* or *ture*), *whar-f* (Fr. *gare*), *wol-f* (from *gul*, "yellow"); and a lip letter once let in, slips into other labials as *scall-op* (*shell*), and with loss of vowel *shar-p* (*shear*), *war-p, whel-p*. Again, *bloss-om, bes-om, bos-om, bottom*, and with loss of vowel, *fil-m* (fell), *cul-m* (coal), *qual-m* (Germ. *qual*). Nay, by a step further in advance, the *m* slips into an *n*, and so brings us to diminutives, which might well have been claimed for our preceding suffix *el* (corrupted to *en*), but that the historical examination decides against the claim. Thus the German *bus-en, bes-en, bod-en* have in the *n* a substitute for an *m*, which grew out of a final aspirated guttural; and the *m* of the Latin second declension of neuters has a like origin. Hence *apium, Ilium*, lead to *apiac-us, Iliac-us*. So again, a primeval *var-agh* may be assumed as the origin of our *brake*, "fern," and of the old German *var-am*, which has since passed into *farren* and *farn*, the last all but identical with our own *fern;* and this assumed *var-agh* stands well beside the Latin *fil-ic-* (nom. *filix*). The assumption of a primeval *pod-agh*, in like manner would explain the existing forms *πυνδ-ακ-, pod-ec-, pot-am* (old Germ.), *boden*, and our own *bott-om*, as well as the Latin *fund-o-* (nom. *fundus*). W is another form of the final consonant, as proved by *skrog, skruff, shrow*, or *shrew*, all existing varieties of what the Greeks called *ὑραξ*, the Romans *sorex*.

But at times, a *t* also supplants the guttural of our suffix; but this change was probably brought about at first by special causes. When the base to which the suffix is added, already possessed a guttural, the pronunciation became not only unpleasant to the ear, but somewhat difficult to the producing organs. Under these circumstances, the guttural is apt to give way, at one time to a *p*, and at another to a *t*. We have already seen examples of the supplanting labial in *scall-op*. So the Greeks from *σκαλ-* "dig," formed a name *σπαλ-ακ-*, not *σκαλ-ακ-*, or "the mole," and the Latin from a base *ac*, "sharp," and a secondary form *forc* (furca), gives us not *ac-ex*, but *ap-ex*, not *forc-ex*, but *forceps, forpex*, or *forfex*. In this way, what were once in actual use, as *emmock*, or *immock, gemlick, gabbock, mammock*, are now found only in the forms, *emmet, gimlet, gobbet, mammet*. We cannot then hesitate, even though the historical proof be wanting, to claim as deduced from a suffix *ock*, the words *spig-ot, cl-ot-, crick-et, lock-et, pock-et* (*poke*, Shaksp.), *smick-et* (*smock*); and a suffix *et* once established, the condition of its origin is forgotten, and we have *eyot, blot, mallet, sillet, tippet, wart* (verruca), *silt*.

But as was above said, one diminutival suffix was not enough, and not only are they added one after the other, but often, at any rate in later days, two at a time. Thus from the verb *leum*, "leap," the Gael forms *leum-ach-an*, or *leum-n-ach*, "a frog." The German *chen*, and our own *kin*, are justly regarded as corruptions of *ich-en* and *ik-in*, and therefore twofold in origin. Thus the German *männchen*, stands for *männ-ich-en*, our *mani-ki-n*. The Latin again has the very same double suffix in *ferul-agon- ole-agin-eus, im-agon-, vor-agon-;* and the Greek in *πολ-ιχν-η*. The suffix *ling* is in like manner made up of *el* and *ing* (the last being a variety of *an* or *en*), and *let*, of *el* and *et;* but in both cases, the two elements have coalesced so completely, that for the creation of a new diminutive, they must be bodily attached as one suffix. The word *πολιχν-η*, just quoted, has, when strictly examined, no less than three suffixes of diminutival power; but even this is not enough to content the passion. A Scotchman will talk of "sic a bonn*ie*, *l-itt-le wee bit* lass-*ick-ie*," where the notion is expressed eight times; and a German amasses five diminutival suffixes in a single word, when from the monosyllabic *ass* he deduces *es-el-in-ch-il-in*.

For adjectives we will briefly refer to *shall-ow* (*shoal*), *callow* (Germ. *kahl*), *fallow*, (Germ. *brach*), *sallow, yellow; black-ish, whit-ish;* to *λιθ-αξ*, "stony," *μαιμαξ-* "boisterous," *σκιναξ*, "nimble," *ἡδυς, βραχυς*, &c.; to the Latin *ferax, edax* (40), and *trux;* to *molli-s, turpi-s* (beside *mollic-ulus, turpic-ulus*), to *lactus, tristis, justus, amicus* (beside the irregular yet fairly established comparatives, *laetic-ior, tristic-ior, justic-ior, amicit-ior*, and the undoubted nouns, *laetit-ia, tristit-ia, justit-ia, amicit-ia*).

In the case of a verb, as Dr. Johnson has noticed when speaking of our own *jingle, sprinkle*, the addition of a diminutival suffix implies "a frequency or iteration of small acts." This character belongs essentially to many verbs, as for example, to the ideas of "rubbing, digging, writing, talking." A suffix then of diminutival power will be well applied in such cases, and indeed generally to a continued state of things. It is this way that *αγ* or *αχ*, with its varieties plays such an important part in the Greek verbs, specimens of which have been already quoted, as *ταρ-ασσ-ω* (*ταραχ-η*) *ορ-υσσω*, &c., in the Homeric iteratives in *εσκ-ον*, in the Latin so-called inceptives *repuer-asc-o, ard-esc-o*, as also, *lac-ess-o, expet-ess-o, incip-iss-o;* the Italian, *fin-isc-o;* French, *fin-iss-ant*, and our own *fin-ish*. Again, the suffix appears almost uncorrupted in *pl-ag-* (*plango*), in *trah-* (*traho, traxi*), in *pl-ec-* (*plecto*), *flec-* (*flecto*), *gnic-* (*nitor*), *frug-* (*fruor, fructus, fruges*), *strug-* (*struo, struxi*), *fl-ug-* (*fluo, fluxi*); and softened into a labial or semi-vowel *vol-v-o* (our *wallow*), *solv-o* (our *sl-ack*), and with the consonant alone preserved in *spar-g-o, mer-g-o, ver-g-o, ter-g-o*.

But passing from these individual words to the secondary or vowel conjugations, the special use of which is to denote continued action, there is strong reason for the belief that the vowels which characterise these conjugations, are themselves but the remnants of the diminutival affix *agh;* and this is the reason why the first conjugation so thoroughly outnumbers the others. The derived nouns, *mirac-ulum, spirac-ulum, orac-ulum, ambulac-rum, lavac-rum*, when compared with *jac-ulum*, tell us in plain terms that the verbs, *mira-, spira-, ora-, ambula-, lava-*, had once a final guttural; *vorag-o* and *solac-ium* (which is the true form, not *solatium*), say the same in behalf of verbs, *vor-agh, sol-agh*. The Greek Doric future *γελαξω*, as we have already said, gives the best evidence that *γελα-* stands for *γελ-ακ*, and so brings it into the closest connection with the German *lach-el-n*, and our own *laugh*. But the pronunciation of this English verb reminds us, that we have to look for a a labial substitute in the classical language. The verb *γρ-αφ-ω*. as well as *scalpo* and *scribo*, all three related words, may be taken as examples. But it is in the first conjugation that the labial form most abundantly presents itself, as shown by the four classes of derivatives, which we represent by the examples: *a. voc-ab-ulum*, compared with *jac-ulum; b. contion-ab-undus* (over 60), compared with the participle *reg-undus; c. am-ab-ilis*, compared with *ut-ilis* (400), and the tense forms *am-ab-am, am-ab-o*, which are of course co-extensive with the conjugation itself. Thus in *am-ab-a-m* it is only the third *a* which, as in *er-a-m, ε-τιθε-α*, denotes past time, and the junction of the two suffixes makes up the idea of "past imperfect;" while in *am-ab-o*, which is without the suffix of past time, we have an imperfect present, and this in many languages is the ordinary form for a future; and the case occurs too in the Greek *ειμι* "I shall go," and the Lat. *er-o* "I shall be," neither of which have any special suffix of futurity. The Sanscrit *e-kar-av-am* "I was doing," from the root *kri* or *kar* "do," has in the two last syllables, what confirms the explanation of *am-ab-a-m*. What has been said is far from all that the subject suggests, but it is time to proceed to other matters.

The pronouns of the third person, whether demonstrative, relative, or interrogative, have in all languages an intimate connection with one another. That the so-called definite article had for its original power the idea of *this* is generally admitted. Then, as regards what appears at first sight to be a formidable difference, that between the ideas of "this" and "that," Bopp observes in his 'Grammar' (§ 371), "That which in Sanskrit signifies 'this' means also for the most part 'that,' the mind (he should rather have said the finger) supplying the place, whether near or remote." Exactly in the same way, it is only by repetition that the idea of another attaches itself to the Latin word *alius*. In form it represents the Sanskrit *anya*, and, except the last letter, is absolutely in form and origin identical with our own *any* (Germ. *ein-ig*), which is but a diminutive of *an* or *one* (Germ. *ein*). Thus, "aliud est maledicere, aliud accusare,". receives its strictest interpretation in the words "it is *one* thing to abuse, *one* to accuse." Then again, the relative is habitually represented by words which are admittedly demonstratival in power and origin, as in our own phrase, "the man *that* I saw," or, still more simply, "*the* man I saw," where it is an error to suppose that any pronoun is understood. So in Greek, more especially for the Ionic dialect, it is often idle to draw a distinction between the article *τους* and the relative *τους*. Our old poets, too, use *there, thence,* with the meaning of *where, whence.* Conversely in Latin conjunctions, such as *postquam,* the literal translation of *quam,* in spite of its identity in form with the relative, is just the same as that of *dem* in *nachdem,*—namely, "this," referring to the words that follow. Precisely in the same way, *ut,* so closely connected with the Latin relative that it may be regarded as a shortened form of *quod,* corresponds for the most part in use with our own conjunction *that.*

A calm consideration of what is meant by a relative clause will perhaps clear this anomaly of all substantial difficulty. A sentence which involves a relative consists of two clauses; that which contains the relative is used solely for defining something, which is to be spoken of in the second clause; and it is this second clause alone which carries with it the news that the speaker wishes to convey. If the object to be defined be present, he may point to it, and no further definition is required. If otherwise, it is convenient to suppose it for the moment to exist in the form of anything at hand. Thus, the lawyers of Rome, in conveying a distant estate in land, took up any clod of earth, and treated it as the actual land then selling. Thus one might say, "This horse I bought yesterday,—this horse I will sell you for 20*l.*;" or in Latin, "Hunc (or quem, no matter which) equum heri emi, hunc tibi vendam." Then, again, identity for the most part in form of the relative and interrogative needs not a word in proof, and the identity in power is clear in the case of the indirect interrogative. Thus, "Dic quis fecit" (*fecerit* in old writers is not necessary), might be translated by "Show me the man who did it," saving that an *s* happens not to be used with the relative; but this *s* has nothing to do with the base of the word, and indeed may at times be omitted from the interrogative itself. To translate *dic* by "show," is simply to revert to the older meaning of the word; and between the two phrases *quis fecit?* and *dic quis fecit,* to give a precedence in time to the latter, is in accordance with the habit of language, which ever cuts down long phrases to shorter; and in this particular case the omission of *dic* was the more natural as it was the standing commencement of every question, and therefore wholly superfluous, if the manner of the speaker suggested that he was asking a question. At the dinner table, "A glass of wine?" is quite intelligible without any interrogative whatever.

As the meanings, then, run all into one another, the chief question remaining is as to identity of form. Now it will be found that an initial thin guttural is found in *qui* and *quis,* in the Greek *κου, κοτερος,* in our own old *quwhat, quwhere.* Then, again, for the demonstrative, we have in the Latin *cis, citra, citerior,* &c.; in the Greek *κεινος,* or *κηνος*; in the Tuscan *quello, questo, colui, costi:* and in a question of this kind, the Tuscan stands on equal ground with the Latin, for we know that the language of Tuscany, even in the days of Roman supremacy, abounded in gutturals. As for the other consonants which are seen at the commencement of third person pronouns, all surprise at the change must fall away when we look to *που* supplanting *κου* in Greek, *pitpit* supplanting *quicquid* in Latin, while the Latin *quis* is the analogue of the Greek *τις,* just as *que,* "and," is of *τε,* "and." And if an *s* is seen in the Latin *sic,* Eng. *so* and *such,* and the compound *whoso,* we have what is perfectly parallel in the Greek *σητες, σημερον,* for *τητες, τημερον.* Then, again, the mere aspirate of *ὁ, ἡ,* beside *το,* and of *ὅς, ἥ, ὅ,* of the Latin *hic,* &c., and our own *he, here, hence,* is just the letter which is constantly superseding, now an *s,* now a *k.* Or if the loss of the aspirate itself in *is, ea, id,* be pressed, we have only to call to mind that what is now written *it* by ourselves was formerly written *hit,* and is still *het* in Dutch. A guttural is of all letters most likely to be corrupted, and hence, if there be reason to suspect that the third person pronouns were of one origin, as in sense they might well have been, the *k* has a stronger claim by far than any of the others, *p, t, s, h,* or zero. Then, as to the end of the word, it will be found that on every side a final nasal presents itself. The Greek exhibits such a letter in *τιν-* (n. *τις*); the Latin in *un-de, alioquin;* the Spanish in *quien;* the Portuguese in *quem;* the Swedish in a nom. *hwem.* gen. *hwems;* the Dutch in a gen. *wiens;* the English in *when-ce* (old *whenn-es*). The Sanskrit grammarians, again, insist that the base of their relative is *kim,* not *ki;* and beyond the limits of our family, as usually defined, the Finn has *ken* for the relative as well as *cu:* and the Turkish *kim,* as well as *kih* and *ki.* Then, again, for the forms which prefer an *s,* the Norse relative is *sem;* the Danish *som,* still retained in our own despised *how-som-ever.* The Slavonic forms for "this" or "that" are *ten* and *sen* in Bohemian, *tom* in Russian. The Norse, for its personal pronoun masculine, has N. *hann,* ac. *hann,* gen. *hans,* dat. *honum;* and for the definite article the same language has a final *n* in the nom. m. f. *en,* and carries this *n* into every oblique of all genders and both numbers. With this evidence so strongly converging to one point,—namely, the syllable *ken*—the question is, what did this *ken* originally denote? One cannot but answer that our own obsolete *ken* in the sense of "look" supplies that meaning of all others which is best fitted to be the origin of demonstrative pronouns. The one difficulty is, can we establish the antiquity of this verb? Something has been already said on this point. It has been traced to the Latin and Greek as the root of *gnosco, gnovi, agnitus, cognitus.* But it also occurs as a particle in Latin, but of course in a reduced shape; for when verbs are degraded to such an office they are always reduced, as in our own *lo,* for *look.* The particles alluded to are *en,* "behold,' and the suffix *ce,* attached exclusively, as it well might be, to demonstratives, as to *hi-c, illi-c, isti-c, si-c, nun-c, tun-c,* or, in fuller form, *hun-ce, hi-ci-ne.* Lastly, for the antiquity and wide extent of the verb *ken,* we need but add, that it exists in Chinese with the very sense desired. It has been thought right to enter into these details in order to establish a point so utterly opposed to the doctrine of pronominal roots as taught by Bopp, and too readily adopted by his followers; and by way of enlivening a subject which to many may appear dull, it may be noticed that occasionally the force of a Latin sentence is brought out more vividly by recurring to the primary meaning of *hic* and *ille.* Thus, in Terence, 'Haut.' 3, 1, 1, *Luciscit hoc iam*—"It is getting light, *look,* already;" and in 'Virg.', 5, 457, *Præcipitemque Daren ardens agit æquore toto, Nunc dextra ingeminans ictus, nunc ille sinistra*—"Now with his right redoubling blows, now, *look, look,* with his left."

The classification of the languages of the world is as yet in a very imperfect condition, as might be expected from the fact that a very small portion of them have yet come fairly within the reach of science. Of the great majority, we possess but short vocabularies, and those obtained under circumstances which justify a strong doubt of their value. It is therefore a matter of but ordinary prudence to abstain from all definite theories as to languages of which so little is known. The Indo-European family is in a very different position. Belonging for the most part to highly civilised societies, each member of this family has at least a dictionary and grammar; and having been long under the scrutiny of men of science, they have severally yielded results of value. Yet even here a too hasty generalisation has been made. It was long before the Keltic branch was admitted to its full rights as a member; and philologers of the German school still draw a line of absolute division between this family and other languages, the accuracy of which the unfettered inquirer must be permitted to doubt. The Finn and Lapp family, for example, are found to have affinities with the Indo-European stock, which are not to be explained by their being so closely in contact with the Scandinavian races, for over and above those importations which are sure to take place where barbarism borders on civilisation, there are coincidences which this contiguity will not explain, such for example as between the Lapp *mocum, tocum, socum,* and the equivalent forms in the Latin *mecum, tecum, secum,* for pronouns and simple prepositions are precisely the sort of articles which are never imported. Again in Norse the negative is *ei, eigi,* in Danish *ikke;* and in Finn *ei, eikă.* The personal endings of a Lapp verb also bear a close resemblance to those of our Indo-European family. Thus the plural of the verb *molso* "change" runs, *molsoimen, molsoite, molsoin.* The interrogative and relative in Finn have generally the form *cu,* with suitable affixes for the cases, &c. Again the verb *lasken,* "let go," and its diminutival form *laskelen,* "let go by little and little," exhibit both in the main syllable and in the suffix *el,* what is strikingly like words in the great European family. Lastly, as the Latin by adding the particle *que* to the relative creates *quisque,* so in Finn the addition of a syllable not unlike *que* to the relative *jo,* that is, *yo* (so like the Sanskrit *ya*) produces *joca,* "every one." In truth a community of pronouns with the Indo-Teutonic family may justly be claimed for several languages which lie far outside the limits as yet assigned to it. To hint at a connection between our family and the Semitic, would shock the ears of most German philologers; and it must be admitted that a sad amount of rubbish in this way affords some excuse for the prevalent dogmatism; yet the two Hebrew numerals *shish* and *shib'* for "six" and "seven," raise, to say the least, a strong suspicion of some affinity, though, no doubt, it must be a most distant affinity. Be this as it may, the Chinese exhibits so many evidences of identity in important words with the Indo-European family, two examples of which have been here given, that some relationship must assuredly exist; and to connect two such remote families is virtually to draw into the circle many others.

In this problem of comparing languages for the purpose of testing their relationship, the first duty is to carefully analyse the words under comparison, so as to separate the essential from the non-essential, secondly to study the laws of letter-change which must subsist between the languages, if any close affinity exist. A mere identity of form, even with identity of meaning, may be the result of mere accident. On the other hand a real identity often exists when the words have apparently nothing in common. Thus, our English *much* and Sp. *mucho* have the same meaning, yet are utterly unconnected; for the law of letter-change leaves not a doubt that *mucho* is the Latin *multo,* Italian *molto,* a word intimately connected with the Greek *πολ-υ, πολλοι,* and so with *πλειον, πλεον, plus,* as well as with the English *fill* and *full;* just as the Spanish *cuchillo* is the Latin *cultello;* whereas the English *much* and its diminutive *muckle* or *mickle* represent *mag* of the Latin *mag-no-* and the Greek *μεγαλη.* Very different is the position of our *such,* and its Latin equivalent *tali-.* Here, utterly different as are the forms, the words are one in origin, *such* being a corruption of *solch,* as seen in the German *solcher,* and this a compression from *so-lich-;* while *tali-,* like so many Latin words, has lost a final guttural, and so represents *ta-lik.* Thus, the only serious difference lies in the interchange of *s* and *t,* a question already considered for the pronouns.

Indeed, had we started from the Scotch equivalent of our *such*, namely, *thilk*, the passage to *tali-* would have been too easy to need a word of discussion. As a last example let the Latin *corulus* be compared with the English *hasel*. Here, the words being of the same sense, the form alone needs consideration; but Lat. *c*=*h*, *r* in Latin has always grown out of an older *s*, and *u* before *l* is the habit of Latin, as *e* before *l* is the habit of English.

The Indo-European family consists of, 1. The Indian branch, with Sanscrit at its head, and Pali, or the sacred language of Ceylon, as an important member. 2. Persian, at the head of which stands the ancient Zend. 3. The Slavonic, which must be subdivided into: *a*, Old Slavic, or the Church language, Russian, Illyrian, Croatian, and the dialects of Carniola, Stiria, and Carinthia; *b*, Slowak of Hungary. Bohemian, the Serbian of Upper and Lower Lusatia, and Polish. The characters which distinguish these two subdivisions are given by Dobrowsky in the preface to his 'Institutiones.' 4. Old Prussian, Lithuanian, Lettish. 5. The Teutonic, divided into three classes: *a*, Scandinavian, including old Norse or Icelandic, Danish, and Swedish; *b*, Low German, including Gothic, old Saxon, old Frisian, Dutch and Flemish, Anglo-Saxon and English, &c.; *c*, High German, or simply German, in its three varieties of old, middle, and new. 5. Greek. 6. Italian, including: *a*, of old time, Latin, Oscan, and Umbrian; *b*, modern or Romance, that is, Italian, French, Spanish, Portuguese, Norman-English, and Wallachian. 7. Keltic, divided into: *a*, Irish, Gaelic, Manx; *b*, Welsh, Cornish, Breton.

The Turanian family consists of: *a*, Turkish, Mongolian, Mandshoo; *b*, Hungarian; *c*, Finn, Lapp, Ostiak, Syriaen, &c.

To the Semitic family belong Arabic, Hebrew, Syriac, Chaldee, Galla, and Berber.

The remainder may be left for the present unclassified.

The following tables are deduced chiefly from Pott's 'Etymologische Forschungen,' Bopp's 'Vergleichende Grammatik,' and Grimm's 'Deutsche Grammatik.' Other valuable works which may be consulted with advantage, are Zeuss 'On the Grammar of the Celtic Languages,' Diez On the Romance Languages, Schleicher On the Lithuanian, Dobrowsky's 'Institutiones' on the Slavic family, and generally the Proceedings and Transactions of the Philological Society of London.

	Sanscrit.	Greek.	Latin.	Lithuanian.	Gothic.	Old High German.
Gutturals.	k	κ, π	c (qu)	k, *Lettish* k and z	h, g	h, g
	(ksh)	ξ, σσ, κτ κ, (π)	x (c-s), c, s	kss, k, ss (=sh), *Lett.* also z	hs, h, g	
	kh	χ				
	g	γ, β	g, b	*Lett.* g	k	ch (=χ)
	gh	χ	g			
	n (guttural)	γ (nasal)	n (guttural)			
Palatals.	ch (as in church)	π, τ	c (qu)	cz (= ch of church), k; *Lett.* ch, z, k	f	v
	chh	σχ	sc, c		sk	sk
	j	γ (β, ζ ?)	g	g, k (in middle of words) *Lett.* also ds.	k	ch (=χ)
	jh					
	n (palatal)	Different nasals	n (guttural)			
Dentals.	t	τ, σ	t, s	t	th	d (t)
	th	τ	t	t	th (t)	
	d	δ, θ	d, l	d	t (d)	z (=ss)
	dh	θ, σ	f, d	đ	d	t
	n	ν, λ	n, l	n (m)	n	n
Labials.	p	π, φ	p, c (qu)	p	f	v
	ph					
	b	β, π	b			
	bh	φ (β)	f, b	b	b	p
	m	μ (β before liquids)	m	m	m	m
Semi-vowels.	y (palatal)	ι, ε, ζ, aspirate	i	j (=y)	j (=y)	j (=y)
	r (lingual)	ρ, λ	r, l	r, l	r, l	r, l
	l (dental)	λ	l	l	l	l
	w or v (labial)	F, υ, ε, β, φ, aspirate	v, g (in middle of words)	w	v	w
Sibilants.	ç, or s (palatal)	κ, σ, aspirate	c (qu), s	s, ss, s (=sh) z, k	h, s	h, s
	sh (lingual)	σ, aspirate	s, r (non-initial)	sz (=sh)	s	s, r
	s (dental)	σ, asp. ρ (Laconian final)	s, r (non-initial)	s	s, z	s, r
	h (guttural)	χ, γ, κ	h, g, c	z (= French j), sz (=sh) g	h, g	k

Numerals.

	Sanscrit.	Zend.	Persian.	Greek.	Latin.	Lithuanian.	Russian.	Gothic.	Old High German.	Modern German.	English.	Erse.	Welsh.
1	êka-	aiva	yik	ἑν, nom. εἱς.	oino-, or uno-	vena-s f. vena	ono, nom. m. onŭ	ain, nom. m. ain-s	ein-	ein	one, an	aen	un
2	dwa-	dwa	du	δυο, δύω	duo-	du f. dvi	dva dvie	tva-	zuene, zuo zuei	zwei	two	da do	dau dwy
3	tri-, ftisar	thri, ftisar	seh	τρι-	tri-	trys	tri	thri-	drie, or dri, drio, driu.	drei	three	tri	tri tair
4	chatvâr- chatur chatasar	chatwâr chathru	chehaur	τετταρ τεσσαρ πισυρ-	quattuor quadra-	keturi f. keturios	cheturi	fidvor fidur	fiuuar	vier	four	keathair	pedwar pedair
5	panchan	panchan	penj	πεντε (πεμπε)	quinque	penki f. penkios	pyat	fimf	vinf	fünf	five	kuig	pump
6	shash	chswas	shesh	ἑξ	sex	szeszi, &c.	shest	saihs	sehs	sechs	six	se	chwech
7	saptan	haptan	heft	ἑπτα	septem septua-	septyni, &c.	sem	sibun	sibun sibuni-	sieben	seven	secht	saith
8	ashtan ashtau	astan	hesht	οκτω	octo	asztuni, &c.	osm vosem	ahtau	ahto	acht	eight	ocht	wyth
9	navan	navan	nuh	ἐννεFα	novem	devyni, &c.	devyat	niun	nium	neun	nine	noi	naw
10	dasan	dasan	deh	δεκα	decem	deszimt deszimtis	desyat	taihun	zehan	zehen zehn	ten	deich	dêg
20	vinsati	visaiti	bist	εικοσι Fικατι	viginti vinginti ?	dvideszimti	dvatzat	tvaitigjus	zehani-	zwanzig	twenty	fichid'.	ugain
30	trinsat	thrisata	si	τριακοντα	triginta	trisdezimt	tritzat	thrijetigive	drizuc	dreiszig	thirty	deich ar fichid	dêg ar ugain
100	satam	satĕm	sad	ἑκατοντα ἑκατον	centum	szimtas, sb.	sto	taihuntehund*	zehanzoc*	hundert	hundred	kett	cant

* But for 200, Goth. tvahunda; Old Germ. zueihunt, and so on.

Declension of the Demonstrative Pronoun.

		Sanscrit.			Zend. According to Bopp's Theory.			Greek.			Latin.		
		M.	F.	N.	M.	F.	N.	M.	F.	N.	M.	F.	N.
Singular.	Nom.	sas	sâ	tat	hô	hâ	tat	ὁς, ὁ	ἁ, ἡ	το	hi-c	hae-c	ho-c
	Acc.	tam	tâm	tat	tem	tanm	tat	τον	ταν, την	το	hun-c	han-c	ho-c
	Gen.	tasya	tasyâs	tasya	tahê	tanhâo	tahê	τοιο, του	τας, της	τοιο, του	huius	huius	hujus
	Dat.	tasmai	tasyai	tasmai	tahmai	tanhai	tahmai	τῳ	τᾳ, τῃ	τῳ	hui-c	hui-c	hui-c
Plural.	Nom.	tê	tâs	tâni, tâ	tê	tâo	tâ		αἱ	τα	hi	hae	hae-c
	Acc.	tân	tâs	tâni, tâ	tan	tâo	tâ	τους	τας	τους	hōs	hās	hae-c
	Gen.	têsham	tâsâm	têsham	taêshanm	taonhanm	taêshanm	των	ταων, των	των	hōrum	hārum	hōrum
	Dat.	têbhyas	tâbhyas	têbhyas	taêibyô	tâbyô	taêbyô	τοισιν	ταισιν	τοισιν	hīs	hīs	hīs

		Gothic.			Lithuanian.			Old Slavic.			Old High German.		
		M.	F.	N.	M.	F.	N.	M.	F.	N.	M.	F.	N.
Singular.	Nom.	sa	so	thata	tas	ta	tai	t'	ta	to	der	diu	daz
	Acc.	thana	tho	thata	tan, ta	tan, ta	tai	t'	tû	to	den	dia	daz
	Gen.	this	thizôs	this	to	tôs	to	togo	toja	togo	des	dera	des
	Dat.	thamma	thizai	thamma	tamui, tam	tai	tamui, tam	tomû	toi	tomû	demu	deru	demu
Plural.	Nom.	thai	thos	tho	tie	tos	tie	ti	ty	ta	diê	dio	diu
	Acc.	thans	thos	tho	tus	tas	tus	ty	ty	ta	diê	dio	diu
	Gen.	thizê	thizô	thizê	tû	tû	tû	tjech	tjech	tjech	dero	dero	dero
	Dat.	thaim	thaim	thaim	tiem(u)s	tom(u)s	tiem(u)s	tjem	tjem	tjem	dêm	dêm	dêm

Declension of the First Personal Pronoun.

		Sanscrit.	Zend.	Greek.	Latin.	Gothic.	Old German.	Lithuanian.	Old Slavic.	Russian.
Singular.	Nom.	aham	azĕm	εγων, εγω	egomet, ego	ik	ih	asz	az	ya
	Acc.	mâm, mâ	manm, mâ	εμε, με	mē, met, mehe	mik	mih	manen	mja	menya
	Gen.	mama, mê	mana mê, môi	εμευς, εμους, εμειο, εμεο, εμευ, εμου, μευ, μου	mei, mis	meina	mîn	manens	mene	menya
	Dat.	mahyam, mê	mê, môi	εμῖν, εμοι, μοι	mihi	mis	mir	man	mnje, mi	mne
Plural.	Nom.	vayam, asmê	vaêm	ἡμεες, ἡμεις, ἀμες	nos	veis	wir	mes	my	mi
	Acc.	asmân, nas	nô	ἡμεας, ημεις, ἡμᾶς ἀμε	nos	unsis	unsih	mus	ny	nas
	Gen.	asmâkam, nas	ahmâkĕm, nô	ἡμειων, ἡμεων, ἡμων	nostrum	unsara	unsar	musû, mus	nas	nas
	Dat.	asmabhyam, nas	nô	ἡμῖν, αμμῖν, αμμι	nobis	unsis	uns	mum(u)s	nam	nam

Declension of the Second Personal Pronoun.

		Sanscrit.	Zend.	Greek.	Latin.	Gothic.	Old German.	Lithuanian.	Old Slavic.	Russian.
Singular.	Nom.	twam	tûm	τυνη, τυ, συ	tu	thu	dû	tu	ty	tü
	Acc.	twâm, twâ	thwanm thwâ	σε	te	thuk	dih	taven	tja	tobya
	Gen.	tava	tava	τεους, τευς, τεοιο, τεου, τεο, τευ; σειο, σεο, σευ, σου	tui, tis	theina	dîn	tavens	tebe	tebya
		twô, tê	thwôi, tê, tôi							
	Dat.	tubhyam thwê, tê	thwôi, tê, tôi	τεῖν, τῖν, σοι	tibi	thus	dir	tav	tebje, ti	tebe
Plural.	Nom.	yûyam, yushmê	yûshĕm yûs		vos	jus	îr	jûs	vy	vü
	Acc.	yushmân vas	vô		vos	izvis	iwih	jus	vy	vas
	Gen.	yushmâkam vas	yûsmâkĕm vô		vestrum	izvara	iwar	jusû, jus	vas	vas
	Dat.	yushmabhyam vas	yûsmaĉibya		vobis	izvis	iu	jum(u)s	vam	vam

Nominative Singular of Nouns.

	Sanscrit.	Zend.	Greek.	Latin.	Lithuanian.	Gothic.
m.	From crude form vrĭka, wolf, vrĭka-s	věhrkô	λυκο-ς	lupu-s	wilka-s	vulf'-s
n.	danam or dâna, gift, dana-m	dâte-m, given	δωρο-ν	donu-m	géra, good	daur', door
f.	jihvâ, tongue, jihvâ	hizva	χωρα, land	terra, earth	rankà, hand	giba, gift
m.	pati, master, pati-s	paiti-s	ποσι-ς, husband	hosti-s, enemy	pati-s	gast'-s, guest
f.	prîti, love, pritis	âfriti-s, blessing	πορτι-ς, heifer	siti-s, thirst	awi-s, sheep	anst'-s, mercy
n.	vâri, water, vâri	vairi	ιδρι, knowing	mare		
m.	sûnu, son, sûnu-s	pasu-s, beast	ιχθυ-ς, fish	portu-s, harbour	sunù-s	sunu-s
f.	tanu, body, tanu-s	tanu-s	πιτυ-ς, pine	manu-s, hand	. . . . .	handu-s
n.	madhu, wine, madhu	madhu	μεθυ	pecu	darkù, ugly	faihu, beast
m. f.	gau or go, bull, cow, gau-s	gâu-s	βου-ς	bō-s		
f.	nau, ship, nau-s	. . . .	ναυ-ς	nav(i)-s		
f.	vâch, speech, vâk	vâk-s	Fοπ-ς	voc-s (vox)		
m.	bhara(n)t, bearing, bharan	baran-s	φερων	feren-s	sukan-s, turning	fijand-s, enemy
m.	atman, soul, âtmâ'	asma, heaven	δαιμων, spirit	sermo', speech	akmu', stone	ahma
n.	nâman, name, nama'	nâma'	ταλαν, wretched	nomen	. . . . .	namô
m.	bhrâtrĭ, brother, bhrâtâ'	brâta'	πατηρ, father	frater	. . . . . .	brôthar
f.	duhitrĭ, daughter, duhitâ'	dughdha	θυγατηρ	mater, mother	duktő	dauhtar
m.	datri, giver, dâtâ	dâta'	δοτηρ	dator		
n.	vachas, word, vachas	vachô	Fεπος	opus, work		

Accusative Singular of Nouns.

	Sanscrit.	Zend.	Greek.	Latin.	Lithuanian.	Gothic.
m.	vrĭka-m	věhrkě-m	λυκο-ν	lupu-m	wilka-n	vulf'
n.	dâna-m	dâte-m	δωρο-ν	donu-m	géra	daur'
f.	jihvâ-m	hizva-nm	χωρα-ν	terra-m	ranka-n	giba
m.	pati-m	paiti-m	ποσι-ν	hosti-m	páti-n	gast'
f.	prîti-m	âfrîti-m	πορτι-ν	siti-m	áwi-n	anst'
n.	vâri	vairi	ιδρι	mare		
m.	sûnu-m	pasû-m	ιχθυ-ν	portu-m	sunu-n	sunu
f.	tanu-m	tanû-m	πιτυ-ν	manu-m	. . . . .	handu
n.	madhu	madhu	μεθυ	pecu	darkù	faihu
m. f.	gâ-m	ga-nm	βου-ν	bov-em		
f.	nâv-am	. . . . .	ναυ-ν	nav-em		
f.	vâch-am	vâch-em	Fοπ-α	voc-em		
m.	bharant-am	barĕnt-em	φεροντ-α	ferent-em	. . . . .	fijand
m.	âtmân-am	asman-em	δαιμον-α	sermon-em	. . . . .	ahman
n.	nâma'	nâma'	ταλαν	nomen	. . . . .	namô'
m.	bhrâtar-am	brâtar-ĕm	πατερ-α	fratr-em	. . . . .	brôthar
f.	duhitar-am	dughdhar-ĕm	θυγατερ-α	matr-em	. . . . .	dauhtar
m.	dâtâr-am	dâtâr-ĕm	δοτηρ-α	datōr-em		
n.	vachas	vachô	Fεπος	opus		

Nominative Plural of Nouns.

	Sanscrit.	Zend.	Greek.	Latin.	Lithuanian.	Gothic.
m.	vrĭka-s	. . . . .	λυκοι	lup'ī	wilkai	vulfô-s
n.	dânâ-n-i	dâta	δωρα	dona	. . . . .	daura
f.	jihvâ-s	hizvâ-o	χωραι	terrae	ranko-s	gibô-s
m.	patay-as	paity-ô	ποσι-ες	host'-es	. . . . .	gastei-s
f.	prîtay-as	âfrity-ô	πορτι-ες	mess'-es	áwy-s	anstei-s
n.	vârî-n-i	var'-a	ιδρι-α	mari-a		
m.	sûnav-as	pasv-ô	ιχθυ-ες	portū-s	sûnu-s	sunju-s
f.	tanav-as	tanv-ô	πιτυ-ες	manū-s	. . . . .	handju-s
n.	madhû-n-i	madhv-a	μεθυ-α	pecu-a		
m. f.	gâv-as	geu-s	βο(F)-ες	bov-es		
f.	nâv-as	. . . . .	να(F)-ες	nav'-es		
f.	vâch-as	vâch-ô	Fοπ-ες	voc-ēs		
m.	bharant-as	barĕnt-ô	φεροντ-ες	ferent-ēs	. . . . .	fijand-s
m.	âtmân-as	asman-ô	δαιμον-ες	sermon-ēs	. . . . .	ahman-s
n.	nâmân-i	nâman-a	ταλαν-α	nomin-a	. . . . .	namôn-a
m.	bhrâtar-as	brâtar-ô	πατερ-ες	fratr-ēs		
f.	duhitar-as	dughdhar-ô	θυγατερ-ες	matr-ēs	dughter-es	
m.	dâtâr-as	dâtâr-ô	δοτηρ ες	datōr-ōs		
n.	vacha(ṅ)s-i	vachanh-a	Fεπε(σ)α	oper-a		

Accusative Plural of Nouns.

	Sanscrit.	Zend.	Greek.	Latin.	Lithuanian.	Gothic.
m.	vrĭkâ-n	vĕhrka-n	λυκο-υς	lupō-s	wilkù-s	vulfan-s
n.	dânâ-n-i	dâta	δωρα	dona	rankà-s	daura
f.	jihvâ-s	hizvâ-o	χωρᾱ-ς	terrā-s	. . .	gibô-s
m.	pati-n	paity-ô	ποσι-ας	hostī-s	. . .	gasti-ns
f.	prîtî-s	âfritî-s	πορτῑ-ς	messī-s	áwy-s	ansti-ns
n.	varî-n-i	var'-a	ιδρι-α	mari-a		
m.	sûnû-n	pasv-ô	ἰχθυ-ας	portū-s	sùnu-s	sunu-ns
f.	tanû-s	tanû-s	πιτῡ ς	manū-s	. . .	handu-ns
n.	madhû-n-i	madhv-a	μεθυ-α	pecu-a		
m. f.	gâ-s	gâu-s	βο(F)-ας	bov-ēs		
f.	nâv-as	. . .	να(F)-ας	nav-ēs		
f.	vâch-as	vâch-ô	Fοπ-ας	voc-ēs		
m.	bharat-as	barĕnt-ô	φεροντ-ας	ferent-ēs		
m.	âtman-as	asman-ô	δαιμον-ας	sermon-ēs	. . .	ahma-ns
n.	nâmân-i	nâman-a	ταλαν-α	nomin-a	. . .	namôn-a
m.	bhrâtrî-n	brâthr-eus ?	πατερ-ας	fratr-ēs		
f.	duhitrî-s	dughdhĕr-eus ?	θυγατερ-ας	matr-ēs	dughter-es	
m.	dâtrî-n	dâthr-eus ?	δοτηρ-ας	datŏr-es		
n.	vachâ(ṅ)s-i	vachanh-a	Fεπε(σ)α	oper-a		

Present Tense of a Verb.—Crude Form, *Stha or Sta or perhaps Stan* (*Cf.* our *stand*).

	Sanscrit.	Zend.	Greek.	Latin.	Old German.	Lithuanian.	Old Slavic.
Sing.	ti-sthâ-mi	hi-stâ-mi	ἵ-στη-μι	sto	stâ-m	stow-mi	sto-jû
	ti-stha-si	hi-sta-hi	ἵ-στη-ς	stas	stâ-s	stow-i	sto-ïsi
	ti-stha-ti	hi-sta-ti	ἵ-στη-σι (ν)	stat	stâ-t	stow	sto-ïtj
Dual.	ti-sthâ-vas	. . .	. . .	. . .	. . .	stow-ìwà	sto-ïva
	ti-stha-thas	hi-sta-thô ?	ἵ-στα-τον	. . .	. . .	stow-ita	sto-ïta
	ti-stha-tas	hi-sta-tô	ἵ-στα-τον	. . .	. . .	stow	sto-ïta
Plural.	ti-sthâ-mas	hi-stâ-mahi	ἵ-στα-μες or -μεν	stamus	stâ-mês	stow-imè	sto-ïm
	ti-stha-tha	hi-sta-tha	ἵ-στα-τε	statis	stâ-t		
	ti-stha-nti	his-stĕ-nti	ἱσταντι(ν) or ἱστᾱσι(ν)	stant	stâ-nt	stow	sto-jatj

Present Tense of the Verb 'To Give.'—Crude Form, (*Da or rather Dan*).

	Sanscrit.	Zend.	Greek.	Latin.	Lithuanian.	Old Slavic.
Singular.	da-dâ-mi	da-dhâ-mi	δι-δω-μι	do	du-(d)-mi	da-(d)-mj
	da-dâ-si	da-dhâ-hi	δι-δω-ς	da-s	du-d-i	da-(d)-si
	da-dâ-to	da-dhâi-ti	δι-δω-τι δι-δω-σι (ν)	da-t	du-s-ti, dust	da-s-tj
Dual.	da-d-vas	. . .	. . .	. . .	du-(d)-va	da-d-eva
	da-t-thas	da-s-thô	δι-δο-τον	. . .	du-s-ta	da-s-ta
	da-t-tas	da-s-tô	δι-δο-τον	. . .	dusti, dust	da-s-ta
Plural.	da-d-mas	da-dĕ-mahi	δι-δο-μες or -μεν	damus	du-(d)-me	da-(d)-my
	da-t-tha	da-s-ta ?	δι-δο-τε	da-tis	du-s-te	da-s-te
	da-dá-ti	da-dĕ-nti	δι-δο-ντι δι-δο-ᾱσι δι-δουσι (ν)	da-nt danunt	dusti, dust	da-d-jatj

Present Tense of the Verb 'To Be.'—Crude Form, *As or Es.*

	Sanscrit.	Greek.	Latin.	Lithuanian.	Old Slavic.	Gothic.
Sing.	as-mi	ειμι-εμμι	es-um, s-um	es-mi	jes-mj	ï-m
	a-si	εσ-σι, εις, ει	es	es-si	je-si	ïs
	as-ti	εσ-τι(ν), εν-τι	es-t	es-ti	jes-tj	ïs-t
Dual.	s-vas	. . .	. . .	es-wa	jes-va	si-(j)u
	s-thas	εσ-τον	. . .	es-ta	jes-ta	si-(j)uts
	s-tas	εσ-τον	. . .	es-ti	jes-ta	. . .
Plural.	s-mas	εσ-μες or -μεν, ειμεν, εμεν	es-umus, s-umus	es-me	jes-my	si-(j)um
	s-tha	εσ-τε	es-tis	es-te	jes-te	si-(j)uth
	s-anti	εασι(ν), εισι(ν), εοντι, εντι	es-unt, sunt	es-ti	s-ûtj	si-nd

LANTANURIC ACID ($C_6H_4N_2O_6$). A peculiar acid obtained by the action of ferrocyanide of potassium upon uric acid. It is probably identical with allanturic acid.

LANTERN. [Skylight.]

LANTERN, MAGIC. [Magic Lantern.]

LANTHANIUM (La). A metal discovered in 1839 by Mosander, in what had been previously supposed to be entirely oxide of cerium. He called it lanthanium, from its having so long escaped notice (λανθάνειν, *to lie hid*). It is prepared by calcining the mixed nitrates of cerium and lanthanium; by this the oxide of cerium becomes insoluble in dilute acids, and the oxide of lanthanium, which is a powerful base, may be extracted by nitric acid diluted with 100 parts of water; when an alkaline carbonate is added to the nitrate of lanthanium, the carbonate of the metal is precipitated. Oxide of lanthanium is not reduced to the state of metal by potassium, but that metal separates a gray metallic powder from the chloride of lanthanium, which oxidises in water with the evolution of hydrogen gas, and is converted into a white hydrate.

Oxide of lanthanium, in the purest state in which it has hitherto been obtained, is nearly white or of a light salmon colour without any admixture of brown, or brownish red; there is every reason to believe that the colour is owing to some impurity, from which it has not been hitherto possible to free it. It undergoes no alteration by calcination at a red heat in close vessels; it restores the blue colour of reddened litmus-paper; when sprinkled with water, it is gradually converted into a hydrate, and becomes a bulky white powder; this alteration occurs very rapidly in boiling water; it dissolves very readily in acids, even when dilute; when boiled in a solution of chloride of ammonium, it expels ammonia and an *ammonio-chloride of lanthanium* is formed. The equivalent of lanthanium is 46·4. Hydrate and carbonate of lanthanium are both insoluble in carbonate of ammonia.

Oxide of Lanthanium (LaO). Lanthanium seems to combine with oxygen in one proportion only; this oxide dissolves in hydrochloric acid without evolving chlorine.

Chloride of Lanthanium (LaCl). When a solution of oxide of lanthanium in hydrochloric acid is evaporated over sulphuric acid, prismatic crystals of chloride of lanthanium of a rose-colour are obtained; it deliquesces on exposure to the air, readily dissolves in alcohol, to the flame of which it imparts no colour. This salt melts in its water of crystallisation, gives off hydrochloric acid, and leaves a mixture of chloride and oxychloride of lanthanium.

Nitrate of Lanthanium (LaO,NO_5) is obtained by dissolving the oxide in nitric acid. It crystallises with difficulty, and forms a rose-coloured saline mass which is deliquescent and soluble in alcohol; the form of the crystal is a prism, and it contains no water of crystallisation.

Carbonate of Lanthanium (LaO,CO_2). The neutral compound is obtained by precipitating the soluble salts of lanthanium with carbonate of soda. It is a white flocculent precipitate, which on drying becomes a white adherent powder.

It has been found by Mosander that a mineral, which was supposed to be a protocarbonate of cerium, contained only a trace of this metal, and consisted almost entirely of a compound of 1 equivalent of carbonic acid with 3 equivalents of oxide of lanthanium.

Sulphate of Lanthanium (LaO,SO_3+3Aq). Dilute sulphuric acid very readily dissolves the oxide; by evaporation, acicular radiating amethystine-coloured crystals are obtained. Possibly however the red colour is due to didymium. This salt gives off water, but does not melt at a low red heat.

Double nitrate of Lanthanium and Magnesium (LaO,NO_5+MgO,NO_5+8Aq). Dilute nitric acid is saturated with equivalent proportions of oxide of lanthanium and magnesia, and the solution left to spontaneous evaporation over sulphuric acid. After a time large, shining, white, crystals are deposited: they possess a sweet styptic taste, and are only very slightly deliquescent.

The salts of lanthanium give white precipitates with phosphoric and oxalic acids and ferrocyanide of potassium, but neither hydrosulphuric acid nor tincture of galls produces any change.

LAO'COON, according to ancient fable, was the son of Priam (according to some, of Antenor), and a priest of Apollo, or as some say of Poseidon, during the Trojan war. While offering, in the exercise of his office, a bullock to render Poseidon propitious to the Trojans, two enormous serpents issued from the sea, and, having first destroyed his two sons, whom he vainly endeavoured to save, attacked Laocoon himself, and, winding themselves round his body, crushed him to death in their folds. This dreadful punishment was inflicted by the goddess Athene for the part Laocoon had taken in endeavouring to dissuade the Trojans from admitting into Troy the fatal wooden horse, which the crafty Greeks had consecrated to Athene.

An enduring celebrity has been gained for this story from its forming the subject of one of the most remarkable groups in sculpture which time has spared to us. It represents the agonised father and his youthful sons, one on each side of him, writhing and expiring in the complicated folds of the serpents. The figures are naked, the drapery that is introduced being only used to support and fill up the composition. This superb work of art, which Pliny describes inaccurately as consisting of only a single block of marble, is formed of five pieces of marble (but in spite of this mistake there seems to be no doubt in the opinion of the learned that this is the identical group alluded to by Pliny), originally decorated the baths of Titus, among the ruins of which, on the side of the Esquiline hill, it was found in the year 1506. The names of the sculptors who executed it are also recorded. Pliny (xxxvi. 5) says, "Laocoon, which is in the house or palace (*domo*) of the emperor Titus, is a work to be preferred to all others, either in painting or sculpture. Those great artists Agesander, and Polydorus, and Athenodorus, Rhodians, executed the principal figure (*eum*), and the sons, and the wonderful folds of the serpents, out of one block of marble."

There has been much difference of opinion among antiquaries on several points connected with this group: first, as to the date of the artists; Winckelmann contending that they are of a good period of Greek art, and as early as Lysippus: the next question discussed has been, whether the sculptor was indebted for the subject to Virgil's fine description ('Æneid,' ii., v. 200), or whether the poet was indebted to the artist. With respect to date, the most careful consideration seems to fix these sculptors as late as the early emperors; and Lessing, whose work on the Laocoon deserves the attention of all who take an interest in the philosophy and capabilities of art, believes that they lived in the reign of Titus. With regard to the subject, it is most probable that the story, being well known, offered advantages for illustration to the sculptor, as it did for description to the poet. As Virgil's priest was habited in his robes during the exercise of his priestly functions, and the group under consideration is entirely naked, the argument is additionally strengthened against the assumption that the artist borrowed from the poet. It is more natural to believe that both drew from a common source, and treated the subject in the way they considered best adapted to the different arts they exercised; the sculptor's object being concentration of effect, the poet's amplification and brilliant description.

This group is justly considered, by all competent judges, to be a masterpiece of art. The subject is of the most affecting and interesting kind; and the expression in every part of the figures reaches, but does not exceed, the limits of propriety. Intense mental suffering is portrayed in the countenances, while the physical strength of all the three figures is evidently sinking under the irresistible power of the huge reptiles wreathed around their exhausted limbs. One son, in whose side a serpent has fixed his deadly fangs, seems to be fainting; the other, not yet bitten, tries (and the futility of the attempt is faithfully shown) to disengage one foot from the serpent's embrace. The father, Laocoon himself, is mighty in his suffering: every muscle is in extreme action, and his hands and feet are convulsed with painful energy. Yet there is nothing frightful, disgusting, or contrary to beauty in the countenance. Suffering is faithfully and strongly depicted there, but it is rather the exhibition of mental anguish than of the ugly and undignified contortions of mere physical pain. The whole of this figure displays the most intimate knowledge of anatomy and of outward form; the latter selected with care, and freed from any vulgarity of common individual nature: indeed the single figure of Laocoon may be fairly referred to as one of the finest specimens existing of that combination of truth and beauty which is so essential to the production of perfect sculpture, and which can alone insure for it lasting admiration. The youths are of a smaller standard than the proportion of the father; a liberty hardly justifiable, but taken probably with the view of heightening the effect of the principal figure. The right arm of the figure of Laocoon is a restoration. Some have thought that the original action was not extended, but that this arm was bent back towards the head; and have supported their hypothesis by the fact of there being a rough and broken surface where they think the hand, or perhaps a fold of the serpent, may have come in contact with the hair.

It has been stated that the group was found in Rome in the year 1506. There is a curious letter, not generally known, but published by the Abbate Fea, from Francesco da San Gallo to Monsignore Spedalengo, dated 1567, in which the circumstances of the discovery are alluded to. He says, "It being told to the Pope that some fine statues were found in a vineyard near S. Maria Maggiore, he sent to desire Giuliano de San Gallo (the father of the writer) to go and examine them—that Michel Angelo Buonarotti being often in their house, San Gallo got him to go also; and so," says Francesco, "I mounted behind my father (*in groppa a mio padre*), and we went. We descended to where the statues were; my father immediately exclaimed, 'This is the Laocoon spoken of by Pliny.' They made them enlarge the aperture or excavation so as to be able to draw them out, and then, having seen them, we returned home to dinner." The group of 'Laocoon and his Sons' is now preserved among the treasures in art in the museum of the Vatican at Rome. A very fine cast of it is in the Greek court of the Crystal Palace, Sydenham.

LAPIDARY WORK. The work of the lapidary is that of reducing, shaping, grinding, and polishing small hard pieces of stone, especially those which go by the names of gems or precious stones. Such stones require different modes of treatment according to their hardness. The diamond, sapphire, ruby, chrysoberyl, and zircon rank among the very hardest; the agate, amethyst, aquamarina, bloodstone, carnelian, carbuncle, cat's-eye, chalcedony, chrysolite, chrysoprase, crystal, emerald, felspar, flint, fluor-spar, garnet, granite, jade, jasper, lapis-lazuli, onyx, opal, porphyry, quartz, sardonyx, serpentine, and topaz, though differing much among themselves in hardness, may be considered as occupying a sort of medium rank; while a softer class of minerals and vitreous substances is that which includes alabaster, cannel coal, coral, enamel, glass, jet, lava, malachite, mother of pearl, satinstone, steatite, &c. It is by means of small revolving wheels that these are cut and polished by the lapidary. The wheels are of iron, lead, wood, and other substances. For cutting, the edge of the wheel is sharp, and is touched with moistened diamond powder, emery powder, or some similar material; and the edge then acts like an exquisitely fine saw, which works its way through the hardest gems when applied to it. For polishing, the gem or stone is held more frequently against the *side* of the revolving wheel, or else against buff-leather fixed to the edge of a broader wheel. One of the most delicate examples of lapidary-work ever executed was the shaping of the world-renowned *Koh-i-noor*, or "mountain of light," the large diamond obtained by Queen Victoria from the chief of the Punjab. This jewel, large and fine as it is, was found to have been badly cut and facetted; Professor Tennant and the Rev. Mr. Mitchell, on having the subject submitted to them, reported that the brilliancy of the diamond might be increased by a careful re-cutting. Messrs. Garrard were entrusted with the work; they engaged the services of M. Coster of Amsterdam, the most highly-skilled diamond-cutter in Europe; Messrs. Maudslay and Field made a small steam-engine, and constructed a revolving apparatus, expressly for the purpose; and the late Duke of Wellington cut the first facet, as an amateur who took great interest in the matter, a few months before his death in 1852. The process of wholly re-shaping the diamond occupied several weeks, on account of the extreme precautions necessary in dealing with a gem of such enormous value. Elaborate as the arrangements were, the lapidary-work was essentially the same in this as in other instances—the friction of a rapidly revolving metal wheel moistened with diamond-powder and water.

The practical applications of the art will be found illustrated in such articles as CAMEO; GLASS MANUFACTURE, *Glass-engraving;* INTAGLIO; and also in some of the mineralogical articles in the NAT. HIST. DIV.

LAPSE. [BENEFICE; LEGACY.]

LARCENY (*latrocinium*, Latin; *larcin* French) is the legal term for theft.

This crime was formerly divided into grand and petty larceny, distinguished by the value of the property taken at one and the same time. It was grand larceny where the value was more than twelve pence; petty larceny where the value did not exceed that amount: a distinction referable to times in which twelve pence was more than equivalent to as many shillings of the present currency. At common law the punishment of petty larceny was whipping or imprisonment; that of grand larceny was death, unless the offender were in a situation to claim benefit of clergy, of which mode of escaping punishment neither women, nor men who were unable to read, or who had been twice married, or who had married widows, or who, not being actually clergymen, had before taken the benefit of clergy, could avail themselves. [BENEFIT OF CLERGY.]

By 7 & 8 George IV., c. 28, the distinction between grand and petty larceny was abolished: and larcenies are now distinguished as simple or compound, sometimes called mixed, larcenies.

I. Simple larceny at common law is committed by wrongfully taking, against the will of the owner, and carrying away the goods of another, with the fraudulent and felonious intent wholly to deprive him of his property therein.

First, there must be a wrongful taking against the will of the owner, which taking may be either actual or constructive. Actual taking against the will of the owner is where goods are taken directly either out of the possession of their absolute owner, or out of the possession of a bailee, or temporary owner. Constructive taking against the will of the owner is either where the possession of goods is obtained from the owner with a preconceived intention on the part of the person to steal them, in which case the original taking is felonious, or where the owner, without divesting himself of the legal possession of the goods, delivers them into the hands of a person who afterwards converts them to his own use or to some other purpose inconsistent with the continuance of the owner's property therein, in which case such conversion constitutes the felonious taking. The doctrine of constructive taking has given rise to many nice distinctions. Generally speaking, there can be no larceny where the possession is voluntarily parted with. Thus, if I lend another my horse for a certain period, and he sells the horse, it is no larceny, but a civil wrong, for which the only remedy is by action. But where the possession of a horse is obtained on the pretence only of borrowing, and with the intent to keep or sell him, such parting with the possession by the owner will not diminish the criminal responsibility of the taker. Larceny is not committed when the possession is obtained in the first instance bonâ fide without any fraudulent intention. Thus where A saves goods from a house on fire, and takes them home, having at the time an honest intention of preserving them for the owner, although the next morning A conceals the goods and denies having had the possession of them, it is a breach of trust, and no felony; and when goods or money are lost, the converting of them by the finder to his own use does not amount to larceny, unless, at the time of conversion, he knows, or has the means of knowing, who is the real owner. Where however the absolute or temporary owner bails or delivers goods to another, but retains the beneficial possession of them, a conversion of the goods by such bailee to his own use will be larceny. A servant entrusted with his master's goods, a shepherd with sheep, &c., who embezzles them, is guilty of larceny at common law, because in such cases the possession of the servant, &c., is in law the possession of the master; but a clerk, or servant, receiving money or goods from a third person, and misappropriating the same, is not guilty of larceny, because the goods, &c., never were in the possession of the master. If the owner is, by whatever means, induced willingly to part with his *property* in the goods, and not merely with the possession of them, the offence does not amount to larceny; as where possession of goods is obtained under colour of a purchase actually completed, although with an intention of running off without paying for them. But where the owner of a horse on sale allows his paces to be tried by a person who mounts and rides off with the horse, it is larceny, as the owner never parted with the property, nor indeed with the possession, for goods in the presence of the owner are in law considered as in his possession, though used by another. Where A goes to B's shop in the name of C, and asks for a hat which C has ordered, and it is delivered to A, who converts it to his own use, it is no larceny, because by such delivery B parted with the *property* in the hat. But if upon A's asking for the hat, B had delivered two hats for C to choose from, and A had converted both or either to his own use, the offence would have been larceny, because B parted with the possession only, and not with the property, as the right of property would have remained in B until C had made his election, and the bare possession was obtained fraudulently. In cases of this description where the property is parted with, the offender is guilty of the statutable misdemeanor of obtaining money by false pretences. (7 & 8 Geo. IV. c. 28, s. 53.)

Various other statutes have been passed to prevent the defeat of justice arising from the application of some of these subtle distinctions in particular cases, as the misappropriations and frauds by bankers, brokers, attorneys, and other agents, and also by trustees (7 & 8 Geo. IV. c. 29, s. 49; 5 & 6 Vict. c. 29; 20 & 21 Vict. c. 54); and the embezzlement by clerks and servants, (7 & 8 Geo. IV. c. 29, s. 49).

Secondly, there must not only be a taking, but also a carrying away, technically called asportation, to constitute which the goods stolen must be actually removed from the position which they before occupied. Entire removal, to however slight a distance, is a sufficient asportation; as if a thief be detected whilst leading a horse out of a field. So where A goes to an inn, and says to the ostler, "Bring out my horse," pointing to B's horse as his own; whereupon the horse is led out; but before A can mount, B comes up. So where a guest, with intent to steal goods out of an inn, removes them down stairs; or a thief, intending to steal plate, takes it out of a chest and lays it upon the floor, or intending to steal a cask from a waggon, removes it from one end of the waggon to the other. But though there must be an actual removal of every part from its previous position, it is not necessary that each portion of the article stolen should be removed from the space which was previously occupied by other portions of that article. Thus where A in raising a bag from the bottom of a coach-boot removes each part of the bag from the space which that specific part occupied, though the whole bag be not removed from every portion of the space which the bag filled in that boot, the asportation is complete. So where A has drawn a book about an inch above the top of B's pocket, B puts up his hand, and A drops the book and it falls back into B's pocket, it is larceny. So where a package is, for the purpose of cutting it open and getting at the contents, merely set on end in the place where it had lain, and the thief is disturbed before he has effected his purpose, the larceny is complete. But where a severance is necessary before the thief can have the entire control over the article, the asportation is not complete until such severance is effected; as where goods in a shop are fastened by a string to the counter, or a purse is entangled with keys in the owner's pocket.

Thirdly, the thing taken must be goods; and at common law larceny could be committed only in respect of personal goods. Things real, or things annexed to the soil, technically called the reality, or which are connected with the soil and freehold, and which are therefore in legal language, said to savour of the realty, were not subjects of larceny at common law. This rule was observed so strictly, that larceny could not be committed by stealing title-deeds, nor by stealing growing corn, grass, trees, &c., unless severed from the realty by the thief or by the owner, or by a third person, and taken at another time.

The subject matter of larceny at common law must also have been of things *in possession*, as distinguished from things (technically called choses) *in action*, that is, things which are of no intrinsic value, but are capable of being made available by action or demand, as deeds, bonds, bills, notes, and other securities for money, &c.

The objection founded upon the connection of the thing stolen with the realty is removed by several provisions of 7 & 8 Geo. IV. c. 29. The stealing of written or printed papers or parchments, being evidence of title to real estate, is made a misdemeanor punishable by transportation for seven years, or by fine or imprisonment, or both. To steal or cut, break, root up, or destroy or damage, with intent to steal, any tree, sapling, or shrub, or any underwood growing in a park, pleasure-ground, garden, orchard, or avenue, or in ground adjoining to a dwelling-house (if the value, or the injury done, exceed one pound), is a felony, and punishable as for simple larceny: so if the trees, &c., be growing elsewhere, and the value or amount of injury exceed five pounds. To steal or break, root up, destroy or damage, with intent to steal, the whole or part of any tree, sapling, or shrub, or any underwood, wheresoever growing, the value of the articles stolen or the injury done being to the amount of a shilling, is punishable on summary conviction by a justice, and for a second offence by imprisonment and hard labour not exceeding twelve months; and if any person so twice convicted afterwards commit any of the said offences, such offender is to be deemed guilty of felony, and is liable to be punished in the same manner as in the case of simple larceny. To steal, or destroy or damage with intent to steal, any plant, root, fruit, or vegetable production, growing in any garden, orchard, nursery-ground, hothouse, greenhouse, or conservatory, is punishable on summary conviction by imprisonment for six months; or by forfeiture, over and above the value of the articles stolen or the amount of the injury done, of such sum not exceeding twenty pounds as to the justices shall seem meet; a second offence is felony, punishable as in cases of simple larceny.

The same statute makes it felony, punishable as in cases of simple larceny, to steal, or rip, cut or break, with intent to steal, glass or wood-work belonging to any building, or any metal, or utensil or fixture fixed in or to any building, or anything made of metal fixed in land, being private property, or for a fence to any dwelling-house, garden, area, or in any square, street, or other place dedicated to public use or ornament; and it is a felony, punishable as in cases of simple larceny, to steal, or sever with intent to steal, the ore of any metal, or any coal, from any mine, bed, or vein thereof. The stealing of any chattel or fixture let to be used with any house or lodging is made a felony, punishable as simple larceny.

With respect to choses in action, the same statute enacts that if any person shall steal any tally, order, or other security, entitling or evidencing title to any share or interest in any public stock or fund, or in any fund of any body corporate, company or society, or to any deposit in any savings' bank, or shall steal any debenture, deed, bond, bill, note, warrant, order, or other security for money, or shall steal any warrant or order for the delivery or transfer of goods or valuable things, the offence shall be deemed felony of the same nature and in the same degree, and punishable in the same manner as the stealing of any chattel of like value with the share, interest, or deposit to which the security so stolen may relate, or with the money due on the security so stolen or secured thereby, or with the value of the goods or other valuable thing mentioned in the warrant or order. It also enacts that if any person shall steal, or shall, for any fraudulent purpose, take from its place of deposit or from any person having lawful custody thereof, or shall unlawfully or maliciously obliterate, injure, or destroy any record, writ, return, panel, process, interrogatory, deposition, affidavit, rule, order, or warrant of attorney, or any original document belonging to any court of record, or relating to any matter, civil or criminal, begun, depending, or terminated in any such court, or any bill, answer, interrogatory, deposition, affidavit, order, or decree, or any original document belonging to any court of equity, or relating to any cause or matter in any such court, the offence shall be a misdemeanor, and subject at the discretion of the court to transportation for seven years, or such other punishment by fine or imprisonment, or by both, as the court shall award. And the stealing, or, for any fraudulent purpose, destroying or concealing a will or other testamentary instrument, is a misdemeanor punishable by transportation for seven years, or by fine or imprisonment, or both.

No larceny can be committed of things which are not the subject of property, as a human corpse, or of things the use of which is common to all mankind, as running water, wild animals in their natural liberty, &c. It is otherwise of animals which are dead, or are reclaimed or confined, and which are useful to man as food or otherwise. But the stealing of dogs, cats, and ferrets, though tame and valuable, and of bears, monkeys, &c., though reclaimed or confined, does not amount to larceny. The stealing of dogs and of beasts and birds, ordinarily kept in a state of confinement, is made cognisable by justices of the peace. (7 & 8 Geo. IV. c. 29; 8 & 9 Vict., c. 47.) And it is a felony, punishable as in cases of larceny, to course, hunt, snare, or carry away, or kill, or wound deer kept or being in the enclosed part of a forest, chase, or purlieu, or in enclosed land in which deer are usually kept. If in an unenclosed part, the offence is made cognisable by a justice of the peace, with power to impose a pecuniary penalty not exceeding 50*l.*; and a second offence, whether of the same description or not, is made felony, punishable as simple larceny. (7 & 8 Geo. IV. c. 29, s. 26.)

Fourthly, the goods taken should generally be the goods of another person.

If a man take his own goods supposing them to be the goods of another, no larceny is committed. It is otherwise where the taking is for the purpose of fraudulently charging another with the loss; as if a man steal his own goods for the purpose of charging the bailee. If a wife take and convert to her own use the goods of her husband, they being but one person in law, it does not constitute larceny.

A joint tenant or tenant in common of any personal chattel cannot commit larceny respecting such chattel as against his co-tenant. But if such chattel be bailed or delivered to the care or keeping of a third party for safe custody, and the effect of the taking be to charge such bailee, it amounts to larceny.

Stealing oysters or oyster brood from a marked-out or known oyster bed, laying, or fishery, is made larceny by 7 & 8 Geo. IV. c. 29, s. 36.

Fifthly, there must be an intent wholly to deprive the owner of the goods stolen of his property therein, which intent constitutes the fraudulent and felonious character of the act. The most common motive for a theft, and the ordinary mode of depriving the owner of his property in the thing stolen, are the conversion of it to the use of the taker; and Blackstone and others have considered that such conversion to the use of the thief, or some benefit to be derived to him, is essential to the completion of the offence, agreeably to the definition of *furtum* in the civil law, "contrectatio rei fraudulosa lucri faciendi causâ." But it appears to be now settled that a wrongful destruction of the goods taken, whereby the owner is wholly deprived of his property therein, is sufficient to constitute this offence, although no benefit is sought to be derived to the taker. Persons convicted of simple larceny were, by the 7 & 8 Geo. IV. c. 29, made liable, at the discretion of the court, to be transported for seven years, or to be imprisoned with hard labour for a term not exceeding two years, and, if males, to public whipping in addition to imprisonment; but the punishment of transportation was taken away by the 12 & 13 Vict. c. 11. The court is empowered to sentence the offenders to be kept in solitary confinement for any period not more than one month at a time, or than three months in the space of one year. (7 Will. IV. & 1 Vict. c. 90, s. 5.) Where the party convicted is a person already under sentence for another crime, the court may award the sentence for the subsequent offence, to commence at the expiration of the former sentence.

Larceny by clerks and servants is punishable by penal servitude, or by imprisonment. (7 & 8 Geo. IV. c. 29, s. 46.)

The Post-Office Act, 7 Will. IV. and 1 Vict. c. 36, s. 26, makes the stealing and embezzling of post letters, letter-bags, &c., felony, punishable with a greater or less degree of severity, according to the nature of the offence and the existence or non-existence of a confidential character in the guilty party. [Post-Office.] Stealing in a dwelling-house to the amount of five pounds, or when accompanied by menaces or threats, or when any one is put in bodily fear, is punishable by penal servitude or imprisonment with hard labour. As cattle are necessarily left in fields, and upon commons and wastes, without any person to attend them, the legislature has interfered to protect property of this description by heavier punishments than those inflicted in other cases of larceny. Cattle-stealers were by several statutes excluded from benefit of clergy; and upon the abolition of the distinction between capital and clergyable felonies by 7 & 8 Geo. IV. c. 29, stealing any horse, mare, gelding, colt, or filly, or any bull, cow, ox, heifer, or calf, or any ram, ewe, sheep, or lamb, or wilfully killing such cattle with intent to steal the carcase or skin or any part of the cattle so killed, was made a felony punishable with death. But now, under 7 Will. IV. & 1 Vict. c. 90, and subsequent statutes, the punishment of this offence is penal servitude for not more than fifteen years, or imprisonment not exceeding three years. Housebreaking is another instance of larceny committed under aggravated circumstances. [Housebreaking.]

A person guilty of larceny may be indicted for the offence at the suit of the crown [Indictment]; and he might formerly have been appealed or accused in a private action brought by the party injured [Appeal] to punish the offender and obtain restitution. The appeal is now taken away; but the party injured, and indeed any other person, may prefer a bill of indictment without the leave or even the knowledge of the crown or its officers. But the crown may interpose by entering a *nolle prosequi* before judgment, or by pardoning the offender afterwards; whereas, in an appeal, the crown could neither stop the proceedings nor pardon the appellee, whose life after conviction and judgment was wholly at the mercy of the appellant. After conviction the prosecutor may in general maintain an action for the value of the property taken, a right, however, which is seldom exercised, as the offender is seldom possessed of property, and, upon conviction, the property of the felon is forfeited to the crown.

Simple larcenies, where the value of the property does not exceed five shillings, or where the age of the offender does not exceed sixteen, may now be tried and summarily determined, with the consent of the accused person, by magistrates in petty sessions, the punishment in such cases being limited to six months' imprisonment. (10 & 11 Vict. c. 82; 13 & 14 Vict. c. 37; 18 & 19 Vict. c. 126.) Persons *confessing* charges of simple larceny, larceny from the person, or as clerk or servant, may under the last-named statute be similarly punished by the same tribunal. (Blackstone's 'Commentaries,' Mr. Kerr's edition, vol. iv. p. 333.)

II. Compound larceny is where the crime of larceny is accompanied by circumstances which the legislature has considered as aggravating the offence and requiring an increase of punishment.

Stealing from the person of another, whether openly or clandestinely, is a felony now punishable by penal servitude or imprisonment. To constitute this offence, the thing stolen must be completely removed from the person of the owner, though such complete removal is not necessary in cases of simple larceny. It is no answer to the charge, that such force or fear was used as would make the offence amount to robbery. [Robbery.]

LARCH: ECONOMICAL USES. The larch and its products are applied to a large number of uses in the arts. The timber is for many purposes more valuable than that of its sister-tree the fir. For instance—it is more free from knots; it is more durable, as the knots which it contains are seldom rotten; it is less liable to shrink; it will not crack with any moderate degree of heat, when in the form of boards or narrow pieces; it is much more tough; and it is susceptible of receiving a much higher polish, developing a grain or texture often singularly beautiful. On all these accounts larch timber has been much sought after in recent years. Railway and canal engineers especially value it, on account of the long period during which it will bear alternations of wet and dry without decay. It has been experimentally determined that when oak and larch posts of equal size are driven into the beds or banks of rivers, the larch rot much less speedily than the oak. On one occasion a plank-bridge was examined after fifteen years, when it was found that the only planks which had not decayed were those made of larch. It has been found a very valuable substitute for the more expensive oak in shipbuilding, chiefly in small vessels. As sleepers for railways, axles for mill-work, hop-poles, and stakes for plants in general, larch possesses great value. Especially for railway-sleepers is this usefulness observable; because, as the sleepers are placed on ground subject to frequent alternations of wet and dry, the power of the timber to resist this action becomes a matter of great importance. Larch is not so useful in common house-carpentry as deal, because it is a wood difficult to saw and plane; a less durable wood is selected on account of its ease in working. The use of larch has been much encouraged by the grand operations of the dukes of Athol. About a hundred and thirty years ago, the hills in the Dunkeld and Blair-Athol districts were barren and almost valueless, scarcely worth a shilling an acre for any industrial purposes. James, the duke of Athol of those days, planted a few larches for ornamental purposes, and then planted two thousand more for timber. It was a thought worthy of a great landed proprietor; for it could only be in the time of his successors that the trees would be old enough to cut down for timber. Much difficulty had to be encountered; for the furze, broom, juniper, and heath, greatly retarded the growth of the young larches; but this obstacle was conquered by perseverance. The next duke planted eleven thousand larches between 1764 and 1774; while the son of this latter, in the fifty-two years from 1774 to 1826, planted the enormous number of *fourteen millions*, some of them even on the summits of mountains. It was calculated about the last named date, that during the second half of the present century all these will successively become magnificent timber trees, suitable for ship-building and large engineering operations; and that, if all went well, the planting would virtually be a creation of property to the amount of six or seven millions sterling.

On the continent, larch is applied to a great variety of purposes. The Rhenish wine-casks are made of this wood, and are said to be more durable than any other. In some parts of France and Switzerland houses are built of larch, by placing bulky squared trunks one upon another; the heat of the sun, melting the resin in the wood, causes it to run down the sides and to fill the interstices between the logs, thereby keeping out both air and moisture. Larch is in general use for water pipes in those countries. The larch vine-props are left in the ground for years together; all around them are props which perish year after year, while the larch itself remains sound.

Other parts of the tree are also applied to useful purposes. The bark is used in France and England for tanning. The leaves are eaten by cattle and sheep. The burnt wood yields very heavy charcoal, excellent for iron foundries. Venice turpentine, so called, is obtained from the larch. In certain parts of France, during four months of summer, the obtaining of this turpentine is a regular employment; a full-grown tree yielding in this time six or eight pounds. Incisions about an inch in diameter are made in the trunk of the trees; small troughs or descending channels are placed in connection with these incisions; vessels are placed underneath; and after regular intervals of a few hours, the vessels become filled with clear turpentine.

It may here be mentioned that within the last few years some little-understood disease has affected the larch plantations in many parts of England; and that a volume has just been published on this special subject by Mr. Macintosh, the author of various works on gardening and planting.

LARD. [Fat; Unguents.]

LARES, among the Romans, were household gods; the guardians of their hearths and families. There is much dispute upon the etymology of this term. Apuleius derives it from *Lar, familiaris*. Ovid speaks of the Lares as the offspring of Mercury and Lara. From a passage in Virgil's 'Æneid,' ix., 255, it would seem that these Lares of the Romans were the *manes*, or souls of their deceased ancestors: it is certain that their worship was closely connected. According to Ovid ('Fasti,' v., 146) there were generally two of them, who were sometimes represented with a dog at their feet. Others were clothed in the skin of a dog. They were of small size, and generally represented in short habits as ready to minister to the needs of the household, and usually held a cornucopia in their hands as a symbol of good housekeeping. The festival of the Lares was celebrated on the kalends of May (Ibid., v., 129) when they were crowned with garlands and sacrifices were offered to them. In the inner part of large houses there was frequently a Lararium or shrine for the worship of the Lares. Pitiscus records an inscription, 'LARIBVS PRO SALVTE ET INCOLVMITATE DOMVS Q. SERTORII.' There seem to have been two classes of Lares, the *Lares domestici et familiares*, which were the family Manes; and the *Lares publici*, which included *Lares urbani, rurales, viales, compitales, marini*, &c. which presided in the localities indicated by their titles. [Manes; Penates.]

LARGE, in music, see Long.

LARGHETTO (Italian), a musical term, a diminutive of Largo [Largo], slow, but less so than Largo.

LARGO, in music (Ital. adverb, *largely*, *widely*), is the second in order of the five classes into which musical movement is divided [Adagio], and signifies *slowly*.

LARYNGITIS. [Croup.]

LATENT HEAT. When a body is exposed to the action of heat so as to change its state, as from a solid to a liquid, it rises to a certain temperature, known as its *melting* or *fusing point*, and remains fixed at that temperature until the whole of the solid shall have been liquefied. [Liquefaction.] During this operation a quantity of heat must evidently enter the body in order to produce liquefaction; and as it produces no effect on the thermometer, it is said to be *combined*, and rendered *latent*, and is also known as the *heat of liquefaction*, or that heat necessary to the liquid state, so that when the body again becomes solid, the heat thus combined is given off in a sensible form.

Latent heat is one of the capital discoveries of Dr. Black. There are various modes of estimating its amount in different bodies, one of which is by means of the calorimeter, an instrument which bears to combined heat the same relation that the thermometer does to sensible heat. The calorimeter was shortly described under Heat, and will be figured and described under Specific Heat. In order to ascertain how much heat is absorbed and rendered latent during the liquefaction of ice, for example, all that is necessary is to place a pound of water of any known temperature in the calorimeter, which is filled with ice, and observe how many degrees the hot water falls through in dissolving a pound of ice. It will be found that the water must give off 142·65° of sensible heat in order to convert ice at 32° into water at 32°. Hence, during the liquefaction of ice, as much heat is rendered latent as would suffice to raise its own weight of water from 32° to 32° + 142·65° = 174·65°.

Since then a pound of ice at 32° absorbs 142·65° in becoming a pound of water at 32°, it follows that the same quantity of heat is given out or rendered sensible, when the ice again passes into water. There are various modes of proving this: Suppose a vessel of water at 60° be immersed in mercury at 60° below the freezing-point of water, or −28°; a thermometer in the mercury will rise, and one in the water will fall until the latter indicates 32°. We will call these two thermometers No. 1 and No. 2. No. 2, then, or that in the water, will remain stationary during the freezing; but No. 1 will continue to rise in consequence of the heat which the mercury receives from the freezing water. When all the water has become solid, then, and not before, will the thermometer No. 2 again begin to fall; but the thermometer No. 1 will rise uninterruptedly until both thermometers meet at some point below 32°. The cold of winter is considerably mitigated by the sensible heat which is given out by freezing water, and when the temperature rises with the return of milder weather a considerable portion of the heat is employed in producing liquefaction.

Similar phenomena accompany the liquefaction of other bodies. When a mass of lead, for example, is put over the fire it rises to 620°; it then begins to fuse, and it remains at that temperature until the whole mass has become liquid: the heat thus absorbed and rendered latent is called *the latent heat of fusion*. The following table gives the latent heat of certain liquids:—

	Fahr.	
Water	142·65°	1·000
Nitrate of soda	113·34	0·794
Nitrate of potash	85·26	0·598
Zinc	50·63	0·355
Silver	37·92	0·265
Tin	25·65	0·179
Cadmium	24·44	0·171
Bismuth	22·75	0·159
Sulphur	16·85	0·118
Lead	9·65	0·067
Phosphorus	9·05	0·063
Mercury	5·11	0·035

It will be seen from the above table, that the latent heat of ice is very considerable, while that of lead is very small: hence ice melts slowly, lead rapidly. Ice cannot melt until it has received as much heat as would raise its own weight of water 142·65°; while lead melts with as much heat as would raise its own weight of water 9·65°. Did ice melt with the same comparative facility as lead, the first thaw would cause inundations by the sudden melting of the snow and ice of winter.

When a liquid passes into the state of vapour there is a further absorption of heat, still more remarkable than in the case of liquefaction. If heat be applied to water at 32°, the temperature will rise through 180° to the boiling-point, which under mean pressure is 212°. [Boiling of Liquids.] At this point the water will pass off rapidly in the form of steam, and during the whole of this time the thermometer will remain fixed; or, in other words, the steam will have precisely the same temperature as the boiling water. We can easily calculate the quantity of heat thus absorbed and rendered latent by the steam, by noting the time required to raise the water through the 180° between 32° and 212°, and also by ascertaining how long it took for the boiling water to pass off into steam. Supposing these times were equal, the same quantity of heat must evidently have been employed in the one case as in the other; but what is the fact? It requires 5½ times as long to convert the water into steam as it did to raise it from 32° to 212°; in other words, the latent heat of steam is 5½ × 180 = 990°.

This enormous quantity of latent heat is again given out when steam condenses into water, and hence steam becomes a powerful source of heat. Indeed any given weight of water in the form of steam at 212°, in being condensed, will raise 5½ times its own weight of water from 32° to 212°.

The heat absorbed during the vaporisation is less in proportion as the temperature of the vaporising liquid is high. A given weight of water vaporised at 212° absorbs less heat than the same quantity vaporised at 180°. It was formerly stated that the increase of latent heat for lower as compared with higher temperatures was equal to the difference of the sensible heats; so that the latent heat added to the sensible heat would always produce the same sum for the same liquid. Taking 950° as the latent heat of steam, as the mean of a number of observers, a certain weight of steam at 212° condensed at 32° gives out 180° of sensible heat + 950° of latent heat = 1130°. The same weight of steam at 250° condensed at 32° gives out 218° of sensible heat, but only 912° of latent heat, still making the sum 1130°. Again, the same weight of steam at 100° condensed at 32° gives out 68° of sensible heat, but as much as 1062° of latent heat, making together, as before, 1130°. M. Regnault, in examining this question, has found however that the sum of the latent and sensible heats is not constant, but increases by a small though constant difference, equal for each degree to an increase of 0·305° Fahr.

Water furnishes a much larger amount of vapour, bulk for bulk, than any other liquid: a cubic inch of water at 212° expanding to 1696 times its volume, or nearly a cubic foot of steam at the same temperature; whereas a cubic inch of alcohol, boiling at 173°, forms only 528 cubic inches of vapour; ether, boiling at 95°, produces only 298 cubic inches of vapour; and oil of turpentine, boiling at 314°, produces only 193 cubic inches of vapour. Now, although the latent heat required to convert such liquids into vapour is much less than that required to convert water into steam, no advantage would be gained in employing them as prime movers, supposing they were as cheap as water, on account of their low expansive force, which must evidently depend on the bulk of vapour produced from a given bulk of liquid.

The determination of the latent heat of vapour is a difficult and delicate inquiry. The subject has been investigated of late years by Professor Andrews, Favre and Silbermann, and others; and we may here shortly state the method adopted by Andrews. The liquid which is to supply the vapour is placed in a flask, the neck of which has a short bend, and is connected with a glass receiver with a spiral condensing-tube immersed in a large quantity of water, the weight of which has been accurately determined. The liquid being distilled over into the receiver, the quantity that condenses is carefully weighed, and the rise in temperature experienced by the water surrounding the receiver is carefully noted. In this way the amount of heat rendered latent is determined by converting a given weight of the liquid into vapour, and then condensing such vapour by means of water, the temperature of which is known before and after the experiment. The following table of the latent heat of vapours is selected from a larger one contained in the new edition of the 1st part of Professor Miller's 'Elements of Chemistry,' 1860:—

Substances.	Equal Wts.	Equal Wts.	Equal Wts.	Equal Vols.	Observers.
	° Cent.	° Fahr.	Steam = 1000	Steam = 1000	
Water . .	536·67	966·6	1000	1000	Regnault.
,,	535·90	964·6	997·9	—	Andrews.
Wood spirit .	263·70	474·6	491·0	872·9	,,
,,	263·86	475·1	491·5	873·8	Favre and Silbermann.
Alcohol . .	208·31	374·9	387·8	991·3	
,,	202·40	364·3	376·9	963·1	Andrews.
Acetic acid .	101·91	183·4	189·7	682·3	Favre and Silbermann.
Acetic ether . .	105·80	190·4	197·0	963·0	
,,	92·68	166·8	172·6	843·5	Andrews.
Ether . .	90·45	162·8	168·4	692·3	,,
,,	91·11	163·5	169·1	695·4	Favre & Silbermann.
Oil of turpentine	74·00	133·2	137·8	1040·5	Brix.
,,	68·73	123·7	128·0	966·9	Favre & Silbermann.
Bromine . .	45·60	82·0	84·8	754·1	Andrews.
Iodine . .	23·95	43·1	44·5	627·9	Favre & Silbermann.

LATH. In building operations two descriptions of laths are commonly used; the first of which are cut out of sawn plank, and the second are split in the direction of the grain of the wood out of timber especially converted or selected for this purpose. The sawn laths are used to receive slates, or tiles, and are usually (as a maximum) 4½ inches in width, laid to a gauge, (or at certain distances measuring from edge to edge) dependent upon the sizes of the slates or tiles themselves. The split laths, whether of fir or of oak, are used for plasterers' work, and they are nailed upon the joists, or quarters of partitions, so as to leave a small interval into which the rendering coat may be forced in a manner to form a key to support the rest of the work. In France and generally upon the continent oak laths are almost exclusively used; whereas in England none but fir laths are to be obtained; they are from 3 to 4 feet long.

The small strips of wood, laid between packages in warehouses, are also known in trade by the name of laths. Plasterers' laths are called *single* when about ¼ of an inch thick; *lath and a half* when about ⅜ of an inch thick; *and double*, when they are about ½ an inch thick.

LATHE. [EARTHENWARE; POTTERY; TURNING.]

LATI'NUM JUS, JUS LA'TII, LATI'NITAS, sometimes also called simply LATIUM, was one of the various civil conditions under which the inhabitants of the Roman world were classed and comprised. The primary distinction of persons was that of freemen and slaves. Freemen were divided, according to the Roman polity, into 1. Cives Romani; 2. Latini; 3. Peregrini, or aliens. The Roman citizen lived under the civil law of Rome, which determined his rights and duties, and he might aspire to the offices and honours of the Roman state.

The rights and duties of those who came under the second of these heads, the Latini, were defined by the Jus Latinum. They formed a considerable and important class, and ranked next to the Roman citizens in privilege. This class, however, was differently formed, and enjoyed different rights at various periods of the history of Rome.

The old inhabitants of Latium, whilst they continued fœderati or confederates of Rome under the Cassian treaty, enjoyed several of the rights of Roman citizens. The rights of a Roman citizen were of two sorts, private, or civil, and public, or political. The principal private rights were the jus libertatis, or personal freedom, by which the Roman citizen was master of his own person, could not be arbitrarily imprisoned nor punished, except after legal trial, and could not be scourged on any account; the jus connubiorum, by which he was enabled to contract a legal marriage with a Roman freewoman, or with those Latinæ or Peregrinæ who enjoyed the privilege of the connubium, and by which his children were also Roman citizens; the jus patrium, the consequence of the connubium, which gave him that unbounded authority over his children which was peculiar to the Roman law, and which no other people were possessed of (Gaius, i. 55; Justinian, 'Institutiones,' i. 9); the jus legitimi dominii, which included the ability of acquiring property, by testamentary gift, mancipatio or nexum, usucapion, cessio, &c.; and the jus testamentorum, by which he was enabled to bequeath property by will.

The chief public or political rights were, the jus census, or having his name registered in one of the tribes and centuriæ; the jus suffragiorum, or right of voting in the comitia; the right of appeal to the comitia from the sentence of the magistrate; and the jus honorum, by which he was enabled to aspire to any of the dignities in the state. Now the freemen of the Latin confederate towns lived under their own laws and therefore were not under the civil law of Rome; they had their own forms of marriage, of testaments, &c., which were valid in their own courts, but not at Rome; they had not the same paternal authority as the Romans over their offspring; they could not purchase, possess, or inherit property at Rome or in the Roman territory; their persons were not under the protection of the Roman law; they might be sent away from Rome, and they and the other Italian socii were sent away repeatedly, among other instances, under the consulship of Lucius Crassus and Mutius Scævola, in the year B.C. 96, just before the beginning of the Social war, to which that expulsion greatly contributed. It would seem, however, that all the towns of Latium were not on the same footing in these respects, and that some of them had adopted of their own choice certain Roman laws, and by so doing had become, according to the Roman legal term, "populi fundi," that is to say, had entered within the pale of those particular Roman laws, and had the benefit of their provisions even at Rome. (Cicero, 'Pro Balbo,' viii.) Whether the Latin confederates had the connubium, or right of intermarriage, has been questioned by some; Niebuhr, however (vol. ii., 'On the Franchise of the Latins') maintains that they had.* As for the public or political rights of Rome which mainly constituted what was called the "civitas," the Latins were not "censi" at Rome, and they could not aspire to the honours and offices of the Roman state, except those who had previously filled certain municipal offices in their own town for a time, after which, by transferring their domicile to Rome and inscribing their names in one of the tribes, they acquired the civitas and all its rights and privileges. It appears also that there were other means by which a Latin or other Italian freeman might obtain the Roman civitas, by rendering some important service to the Roman state. With regard to the right of suffrage, it is not clear under what conditions the municipes of the Latin cities enjoyed it, but it appears that they came at times to vote at Rome on certain occasions, but then they had no fixed tribe, and voted in a tribe which was drawn by lot, and they might, as it has been said already, be ordered away by the magistrates previous to the day of voting, as was done by the consul Virginius, the colleague of Spurius Cassius. In the year B.C. 123, they came to Rome to vote in favour of the laws proposed by Caius Gracchus, but the consul C. Fannius ordered them away immediately. The civil condition of the Latins, or Jus Latinum, was therefore inferior to that of the Romans, but next to it in importance, and a kind of intermediate step towards obtaining it. They had, even at Rome, some advantages over the Peregrini, or aliens, who were domiciled in that city.

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* Notwithstanding all that has been written on the subject, it is not so easy to say precisely what the connubium was. The only intelligible definition is that of Gaius (i. 56), who, when speaking of the marriage of a Roman citizen with a Roman woman or with a Latina or Peregrina with whom the connubium existed, observes that the effect of the connubium was that the children followed the condition of the father, were consequently Roman citizens and subject to the patria potestas. That the like consequence followed if a Latin married a Roman woman, as to the rights of such children as Latin citizens, is merely the corresponding and correlative part of the connubium. But that the connubium alone enabled a Latin citizen who married a Roman woman to confer on his children the rights of Roman citizens, and himself to acquire the patria potestas, seems inconsistent with the notions of Roman citizenship. The subject of the Jus Latii, and of the connubium in connection with it, is very difficult to understand, and the obscurity is by no means diminished by the way in which Niebuhr has handled it.

When the Romans began sending out colonies to several towns of Latium, such as Ardea, they probably placed the colonists on the same footing as the old Latin inhabitants, namely, under the Jus Latinum. And afterwards they followed the same system with regard to colonies which they sent to other parts of Italy, and which were called Latin colonies, though this name did not mean that they consisted of Latins, but that the colonists, whether Romans or Latins or from other parts of Italy, were placed, with regard to Rome, on the same footing as the inhabitants of Latium. The two principal advantages of their condition were—1st, that they enjoyed municipal independence, had their own senate, chose their own local magistrates, and were not subject to the Roman prætor; and 2nd, that those who filled important municipal offices for one year in the colony acquired the full right of the Roman civitas, and, by transferring their domicile to Rome, might aspire to all the honours and offices of the republic.

At the time of the second Punic war there were thirty of these colonies in various parts of Italy. Twelve of them, after the battle of Cannæ, being weary of the protracted war, refused to give any further assistance in men and money against Hannibal, saying that the Romans ought to make peace with Carthage. These colonies were Ardea, Nepete, Sutrium, Alba, Carseoli, Cora, Suessa, Circeii, Setia, Cales, Narnia, Interamna. ('Livy,' xxvii. 9.) The other colonies remained faithful, continued to furnish their contingents, and were thus the means of saving Rome from destruction. These, it would appear from a passage of Cicero ('Pro Cæcina,' 35), received as a reward the commercium with Rome, or the faculty of acquiring Quiritarian ownership ('Gaius,' ii. 40), of taking by testamentary gift from Roman citizens, and of making a will according to Roman forms, &c.

When by the Julian law the people of Latium and other allies received the full Roman franchise, the Latin colonies shared also the boon. They obtained the civitas, all their citizens had the same civil rights as those of Rome, and if they came and settled at Rome, they enjoyed all the political rights. At this period therefore the old Latinitas, as a distinct civil condition of part of the inhabitants of Italy, was at an end.

But in the following year, under the consul Cn. Pompeius Strabo, the towns of Transpadane Gaul, which were filled with a mixed population of Italians and Gauls, had adopted the Latin language, and remained faithful to Rome in the midst of the defection of the Social war, were raised to the rank of Latin colonies, though no colonists were sent to them. By this new Latinitas, which was called "Minus Latium," or the "lesser Latin franchise," compared with the old Latinitas, the Transpadane towns continuing to govern themselves according to their own laws, were allowed the commercium, but not the connubium, with Rome; and they obtained such share of political privilege that persons who filled magistracies and offices of honour in such towns thereby acquired the full Roman franchise, and they alone. Afterwards many other towns and provinces were raised to the rank of Latin colonies in the same degree; as, for example, the towns of Sicily obtained it from Julius Cæsar.

This is the Latinitas, or Jus Latinum, which existed in later ages of the republic and under the empire, until Caracalla bestowed the Roman citizenship upon the provinces. The principal conditions of this Latinitas will be found in the following passages of Ulpian. Ulp. Frag. Tit. ii., s. 16, Tit. v. s. 4 & Tit. xix. s. 4, in the last of which there is another kind of Latini mentioned; namely, the Latini Juniani. This was a new kind of Latinitas, introduced by the Lex Junia Norbana, passed under the consulship of M. Junius Silanus and C. Norbanus Flaccus, in the tenth year of the reign of Tiberius, and the twentieth of our era. By this law freedmen who were emancipated without certain forms ('Gaius,' i., 17, 22, &c.) and their offspring were placed not under the Jus Civium Romanorum, but under the Jus Latinum, and this even under peculiar restrictions. They had the commercium, but not the connubium. (Savigny, 'Ueber die Entstehung und Fortbildung der Latinität als eines eigenen Standes im Römischen Staate,' in the 'Zeitschrift für Geschichtliche Rechtswissenschaft,' 4th vol., 2nd No., Berlin, 1823.) Justinian ('Cod.,' b. vii., ch. 6) at last abolished this Junian or individual Latinitas, and as the Latinitas of the colonies had ceased long before, all distinction between Latin and Roman was then at an end.

The great importance which the Romans attached to the grant, not only of the political franchise or suffrage, but also of the connubium and commercium, was an effect of their exclusive policy. When they subdued a confederate people, such as most of the Italian nations were, they left to each town its laws and its local magistrates, but forbade the general assemblies of the nation; they restricted or entirely forbade the intercourse between one town and another, so that the people of each could not marry out of their respective district. They pursued afterwards the same policy in the countries which they conquered beyond the limits of Italy, as in Macedonia, which they divided into four parts, forbidding all communication between them.

We must now speak of the Jus Italicum. Sigonius understood it to be a sort of middle condition, between that of the Latini and that of the Peregrini, or aliens, with regard to Rome. But Savigny contends, and apparently with reason, that the Jus Italicum did not affect single individuals, but whole towns, namely, provincial towns out of Italy, to which it was granted, and that it consisted—1st, in the right of having their own free institutions and administration; 2nd, in being free from tax to Rome; 3rd, in having the ownership of property in the territory of those towns regulated according to the Quiritarian or Roman laws, and consequently subject to usucapion, cessio juris, mancipatio, and vindicatio. This last provision was an important security to property, and it placed the towns Juris Italici above all other provincial towns, whether governed by a prætor from Rome or liberæ, which had not the same right. Towns having the Jus Italicum are mentioned by Pliny in Spain and Illyricum; Constantinople is mentioned in the Theodosian code as enjoying the Jus Italicum, and in the Pandects ('De Censibus,' b. l., tit. 15) other towns are mentioned as possessed of the same right. (Savigny, 'Ueber das Jus Italicum,' in the 'Zeitschrift' above mentioned. See also, on the whole of this intricate matter concerning the Jus Latii and Jus Italicum, Sigonius, *De jure Antiquo Italiæ*; Cicero, *Pro Balbo*, with the *Notes* of Grævius and Manutius; Niebuhr's 'History of Rome.')

LATITUDE. [LONGITUDE AND LATITUDE.]

LATITUDE, METHODS OF FINDING. [LONGITUDE AND LATITUDE, METHODS OF FINDING.]

LATUS RECTUM. [ELLIPSE; HYPERBOLA; PARABOLA.]

LAUDANUM. [OPIUM.]

LAUGHING GAS. [NITROGEN; *nitrous oxide*.]

LAUGHTER, as physically defined, is an emotion entirely confined to the human species. It is a peculiar agitation of the body, an organical titillation as it were, which, rising suddenly and irresistibly, affects at once the face and throat, the thorax and the abdomen. Although this physical phenomenon is usually more or less loud, it is sometimes almost imperceptible, and only traceable by a slight muscular motion of the face and mouth. It is usually a pleasant sensation, but occasionally, as in cases of hysteria, it assumes a painful character, and is no longer under the slightest control of the will. While however the corporeal phenomenon is so simple, the nature of the mental state, and of the object by which it is produced, is more complicated and debateable. On this subject a great variety of opinions has prevailed. Among the ancients there is more of unanimity than among the moderns. According to Aristotle, the ridiculous is some error in truth or propriety, but at the same time neither painful nor pernicious (*τὸ γάρ γελοῖον ἐστὶν ἁμάρτημά τι καὶ αἶσχος ἀνώδυνον καὶ οὐ φθαρτικόν.* 'De Poet.,' 6, § 1). Nearly coincident with the foregoing is the view of Cicero, who, while he declares that the ridiculous is incapable of any rigorous definition, admits that the chief, if not the sole object of laughter, is that which, without impropriety, marks out and exposes an impropriety ("Hæc enim ridentur vel sola vel maximè quæ notant et designant turpitudinem quandam non turpiter:" 'De Oratore,' 2, n. 235). Quintilian considers it to be absolutely indefinable ("Anceps ejus rei ratio est," lib. vi., c. 3). At the same time, by adducing the opinion of Cicero, that the improper and the deformed constitute the province of ridicule, and affirming that ridicule is near allied to contempt ("a derisu non procul abest risus:" *Ibid.*), he approximates to the strong opinion of Hobbes among moderns, according to whom, the source of laughter is "a sudden glory arising from conception of some eminency in ourselves, by comparison with the infirmity of others, or with our own formerly" ('Human Nature,' ch. ix., s. 13). With Hobbes's opinion, that of Helvetius coincides, who makes pride the source of laughter. Beattie and Priestley agree in making the ridiculous to arise out of a misrelation or incongruous union of objects; while Lord Kames considers a contrast to be the essence of the laughable. The latter view is adopted by Mendelssohn and J. Paul Richter. The former ('Dialogue' iii., 'Klein phil. und æsth. Schriften') makes it to be grounded on a contrast between perfection and imperfection, which however must be unimportant and but slightly interesting to us, and must amount to no more than an extravagance or inconsistency. The latter (in his 'Vorschule der Æsthetik,' p. 143) makes the ridiculous to be the contrary of the sublime, and consequently the infinitely small. Closely coincident with this view is that of Campbell ('Philosophy of Rhetoric,' b. i., ch. ii.), who observes that "ridicule in futile objects hath a similar effect to that produced by what is called the vehement in solemn and important matters." Lastly, Kant ('Kritik der Urtheilskraft,' p. 225, 2nd ed.) makes the ridiculous to arise from the sudden conversion into nothing of a long-raised and highly-wrought expectation.

According to Shaftesbury ('Characteristics,' 'Essay on Wit and Humour') ridicule is the test of truth, and he adduces in support of his view the words of Gorgias of Leontini, "Confute ridicule by seriousness and seriousness by ridicule" (*τὴν μὲν σπουδὴν διαφθείρειν γέλωτι, τὸν δὲ γέλωτα σπουδῇ.* Arist., 'Rhet.,' lib. 3, ch. xviii.). In order to adjust the sentence to his own view, Shaftesbury adopts the Latin version, "seria risu, risum seriis *discutere*;" it is however clear from the context where the passage is quoted, that Gorgias was there recommending an orator to endeavour to remove the impression which his opponent may have made upon his auditors by employing a directly opposite style of address. But the maxim of Shaftesbury admits only of a negative application, for ridicule, at most, is only fitted to refute error. In truth however it is not properly levelled at the false, but at the absurd in tenets and opinions. The ridiculous is not any fixed and constant property of certain objects, but it is purely relative and dependent upon the subjective states and conditions of individual minds. The simpleton and the boor laugh heartily at what scarcely provokes a smile in the educated man and the sage; and on the other hand, much will excite a laugh in the latter, which would not move a muscle in the face of the former. Such again is the effect of a gay or a gloomy temperament, that a Democritus will laugh where a Heraclitus would weep.

LAUREATE, POET, an officer in the lord chamberlain's department of the royal household. The appellation "laureate" seems to have been derived through the Italian, from the Latin *laurus*, "a bay," in allusion to the ancient practice of crowning poets. Petrarch received the crown at Rome in 1341, and Tasso in 1594. The earliest mention of a poet-laureate in England, under that express title, is in the reign of Edward IV., when John Kay received the appointment. Warton, however, in his 'History of English Poetry,' shows that the poet-laureate is undoubtedly the same officer who in the reign of Henry III. is styled *Versificator regis*, the "king's versifier," and to whom a hundred shillings were paid as his annual stipend. Skelton (writing in the reign of Henry VII.), in three or four of his poems, styles himself "poet laureate;" but the laureateship of which he speaks was a degree granted by the university (in his case of Oxford) for proficiency in 'grammar,' in which versification was included. With the degree was given a laurel wreath. Skelton was one of the last who received this degree. But though

> "By hole consent of ther Senate
> *He* was made poete lawreate,"

and in consequence, wore as laureate a suit of white and green, on which the word Calliope was embroidered, he also held the office of 'laureate to the king,' Henry VIII., whose tutor he had been. Ben Jonson is said to have been the poet-laureate to King James I. In the reign of Charles I., 1630, the first patent of this office appears to have been granted, which fixed the salary or pension attached to it at 100*l.* a year, with an additional grant of a tierce of Canary wine from the king's stores; before this there seems to have been no fixed salary, the sum paid being rather in the shape of a gratuity. The succession of poets-laureate since the time of Charles II. has been—John Dryden, Nahum Tate, Nicholas Rowe, Laurence Eusden, Colley Cibber, William Whitehead, Thomas Warton, Henry James Pye, Robert Southey, William Wordsworth (with a salary of 300*l.* a-year), and, since 1850, Alfred Tennyson. A commutation was agreed to of 27*l.* for the allowance of wine, by Southey, while he held the office.

LAURIC ACID. [LAURYL.]

LAURINE ($C_{44}H_{30}O_6$?), an acrid and bitter principle contained in the berries of the laurel; its smell resembles that of laurel oil. It is insoluble in water, and little soluble in cold alcohol, but more so in boiling alcohol and in ether; it crystallises from solution in needles. When heated it melts, and volatilises without leaving any residue. To sulphuric acid it first imparts a yellow and afterwards a reddish-yellow colour; in cold nitric acid it liquefies, and floats upon the surface; it bears considerable resemblance to solid expressed oils; the berries contain only about 1 per cent. of this substance.

LAURONE. [LAURYL.]

LAUROSTEARIC ACID. [LAURYL.]

LAUROSTEARIN. [LAURYL.]

LAUROSTEARONE. [LAURYL.]

LAURUS NOBILIS, the true (*Cæsar's*) laurel, or sweet bay, *Medical properties of.* Of this tree or large shrub, the berries only are officinal in this country, the leaves and berries on the Continent. Both contain a volatile oil; the berries also a fixed or expressed oil, called laurel fat or oil of bays. The berries analysed by Bonastre yielded: volatile oil, 0·8; laurin, 1·0; fixed oil, 12·8; wax (stearin), 7·1; rosin, 1·6; uncrystallisable sugar, 0·4; gummy extractive, 17·2; bassorin, 6·4; starch, 25·9; woody fibre, 18·8; soluble albumen, traces only; an acid, 0·1; water, 6·4; salts, 1·5; ashes, 1·2. The volatile oil can be procured from the leaves or berries by distillation. It consists of two distinct isomeric oils, separable by re-distillation. Laurin is a true camphor, similar to that obtained from other Laurineæ. It may be extracted by rectified alcohol.

The fixed oil may be obtained from either the fresh or dried berries; the latter require to be macerated or exposed to steam previous to being pressed. The most remarkable point in regard to this oil is, the part of the fruit in which it is lodged, viz.:—the endocarp, most fixed oils being in the seed, but this fruit, the olive, and a few others, have it in the endocarp.

The bruised leaves, and the berries, are tonic, carminative, and febrifugal; but they are little used in medicine. The fixed oil is in extensive use in veterinary medicine.

It is important to remark that the use of bay leaves, in cookery, to flavour puddings, cheese-cakes, custards, &c., has led in several instances to serious mistakes. In many cases the leaves of cherry-laurel, which contain a volatile poisonous oil, and the elements of prussic acid, are used by cooks as recklessly as bay-leaves—having got the name simply of laurel, instead of *cherry-laurel*. Even sculptors have encircled the brows of their marble heroes with the wrong leaf.

LAURYL ($C_{24}H_{23}O_2$). An hypothetical radical contained in lauric acid and the compounds derived from lauric acid. It is homologous with acetyl, propyl, butyl, &c. [NEGATIVE RADICALS.]

Hydride of lauryl ($H, C_{24}H_{23}O_2$) is not known, but a derivative of it, termed *laurone*, or *laurostearone*, has been obtained by the destructive distillation of laurate of lime. It is a crystalline body: melting point 151° Fahr. It contains ($C_{22}H_{23}, C_{24}H_{23}O_2$), the electropositive hydrogen in hydride of lauryl being replaced by the electro-positive radical ($C_{22}H_{23}$); a radical bearing exactly the same relation to the lauryl that the methyl does to the acetyl in acetone.

Lauric acid, laurostearic acid, or *pichurinstearic acid* ($C_{24}H_{24}O_4 = \left.\begin{matrix}C_{24}H_{23}O_2\\H\end{matrix}\right\}O_2$), was first obtained from the fixed oil of bay-berries (*Laurus nobilis*), hence the name. It is also contained in the solid fat of sassafras nuts or pichurin beans [NECTANDRA, *Puchury minor*, in NAT. HIST. DIV.], in cocoa-nut oil, and in cacao butter. By saponification with potash these fatty matters yield laurate of potash, from which the lauric acid may be separated by tartaric acid, gentle application of heat causing the bitartrate of potash to subside and the melted lauric acid to float on the surface.

Lauric acid is, at ordinary temperatures, a transparent crystalline mass. It is very soluble in alcohol or ether, the solution possessing a strongly acid re-action. By careful manipulation it may be obtained in silky needles. Its specific gravity is 0·883; melting point between 108° and 110° Fahr.

Laurostearin is a combination of lauric acid and glycerin, forming the natural fats already mentioned. When purified by repeated crystallisation from boiling alcohol it forms a mass of white, brilliant, acicular crystals. Melting point about 112° Fahr.

Laurates have the general formula ($C_{24}H_{23}MO_4$); they are uncrystallisable.

Laurin is a substance crystallising in prisms on evaporating the alcoholic mother liquors from the preparation of laurostearin. It differs from the latter body in being very soluble in cold alcohol. Its composition is said to be $C_{44}H_{30}O_6$.

LAVANDULA. The medical uses of the products of various species are given under this head in the NAT. HIST. DIV.

LAW. In treating of the word *law* we will first explain its etymology, and the etymology of the equivalent words in the principal languages of the civilised world; we will next determine the strict and primary meaning of law, together with its various secondary meanings; we will afterwards state the most important species of law, in the strict sense of the word; and finally, we will make a few remarks on the origin and end of law.

1. *Etymology of Law, and the equivalent words in other languages.*—In the Greek language the most ancient word for law is *thémis* (*θέμις*, which contains the same root as *τίθημι*), meaning "that which is established or laid down." The common Greek word for law, after the Homeric period, is *νόμος*, which first occurs in the 'Works and Days' of Hesiod (v. 274-386, Gaisford), and contains the same root as *νέμω*, to *allot* or *distribute*. The only word which the Greek language possessed to signify a *legal right* was *δίκαιον*, or *δικαίωμα*. (See Hugo, 'Geschichte des Römischen Rechts,' p. 962, ed. xi.)

Jurisprudence was never cultivated as a science by the Greeks before the loss of their independence. Many causes concurred to prevent the Greeks from adding jurisprudence to the numerous subjects which they first subjected to a scientific treatment. The chief of these causes was perhaps the generally *arbitrary* character of the Greek tribunals, both in the democratic and oligarchical states. The Lacedæmonians had no written laws (see Aristotle's account of the jurisdiction of the Ephors in 'Polit.,' ii. 9; compare Müller's 'Dorians,' b. iii., ch. 6, s. 2; ch. 11, s. 2; and see Justinian's 'Institutes,' lib. i., tit. 2, s. 10), and they were besides too great contemners of learning and science to cultivate law in a systematic manner. The Athenians possessed a considerable body of written laws, and, with their extraordinary talent both for speculation and action, they would probably have contributed something towards reducing law to a science, if the large numbers of the judges (*δικασταί*) in their courts had not led to a popular and rhetorical treatment of the questions which came before them, and, by diminishing the sense of personal responsibility, facilitated arbitrary decisions. (Xen., 'Mem.' iv. 4, 4.)

For the first scientific cultivation of law the world is indebted to the Romans. "How far our ancestors," says Cicero, "excelled other nations in wisdom, will be easily perceived on comparing our laws with the works of their Lycurgus, Draco, and Solon; for it is incredible how rude and almost ridiculous every system of law is, except that of Rome." ('De Orat.,' i. 44.) Apart from the general ability of the Romans in the business of civil and military government, the systematic cultivation of law in Rome is perhaps owing chiefly to the fact that the Roman tribunals were composed of a single judge, or magistratus. (Hugo, *Ibid.*, p. 345.) The persons filling the offices of *prætor urbanus* and *prætor peregrinus* (the magistrates who ultimately exercised the chief civil jurisdiction) were changed annually; and it was found convenient that every new prætor should, on his accession to his office, publish an authentic statement of the rules which he intended to observe in administering justice. In process of time these rules, known by the name of the *prætor's edict*, were handed down, with little alteration, from one prætor to another; and they furnish a text for the commentaries of the Roman lawyers, many of whose expository writings were drawn up in the form of treatises *ad edictum*.

The scientific cultivation of law among the Romans naturally led to the formation of a technical legal vocabulary in their language. The Latin is accordingly very rich in legal terms, many or most of which have been retained in the modern languages of western Europe, especially in those countries whose legal systems are founded on the Roman law. The only terms, however, with which we are at present concerned are those which denote the most general notions belonging to the subject of jurisprudence. *Lex*, which has the same etymological relation to *lego* that *rex* has to *rego*, meant properly a measure proposed by a magistrate in the *comitia*, or assembly of the people. A *lex* was not necessarily a rule, and might relate to a special case (Hugo, *Ibid.*, p. 327); but as most of the *leges* proposed by the magistrates were general, the word came to signify a written law. *Jus* denoted law generally, whether written or unwritten; it also denoted a legal right or faculty. *Lex* signified "*a* law;" *jus* "law" generally. (Austin's 'Province of Jurisprudence,' p. 307.)

The Romance languages have retained the word *lex* in the Latin acceptation (*legge* Italian, *ley* Spanish, *loi* French). They have however lost the word *jus* (though they retain many of its derivatives), and have substituted for it words formed from the passive participle of *dirigo* (*diritto* Italian, *derecho* Spanish, *droit* French), probably after the analogy of the German *recht*.

Nearly all the Teutonic languages (including the Anglo-Saxon) possess some form of the word *recht*, with a double sense equivalent to the Latin *jus*, namely, *law* and *faculty*. The modern English uses *right* in the sense of *faculty* alone. The High German has *gesetz* (from *setzen*, "to place," like *θεσμὸς* and *θέμις*), for a written law equivalent to *lex*. The Low German languages have, instead of *gesetz*, a word formed from *legen*, to lay down, which in Anglo-Saxon is *laga* or *lag*, in modern English *law*. The word *law*, however, in modern English, has not the limited sense of *gesetz*, but is coextensive with the Latin *jus*, when the latter does not signify *faculty*. We do not wish to dwell unnecessarily on these etymologies, but we will shortly notice that, besides *regt*, the Dutch language has the word *wet* in the sense of *law*. This word is derived from the ancient *withan*, Gothic, "to bind," and is equivalent etymologically to the Latin *obligatio*. The English verb *to wed* is the same word. *Ehe*, which signifies *marriage* in modern German, originally meant *law* or *ordinance* ('Nibelungen Lied,' v. 139, 5061); so that the Dutch *wet* and the English *wed* stand to one another in the same relation as the ancient and modern senses of *ehe*.

2. *Proper and improper Meanings of the word Law.*—A *law*, in the strict sense of the word, is a general command of an intelligent being to another intelligent being.[*] Laws established by the sovereign government of an independent civil society are styled *positive*, as existing by *positio*. [SOVEREIGNTY.] When law is spoken of simply and absolutely, *positive* law is always understood. Thus in such phrases as "a lawyer," "a student of law," "legal," "legality," "legislation," "legislator," &c., positive law is meant. Positive law is the subject-matter of the science of jurisprudence. [JURISPRUDENCE.] Every general command of a sovereign government to its subjects, however conveyed, falls under the head of positive laws. The general commands of God to man (whether revealed or unrevealed) are called the laws of God, or the Divine law: they are sometimes also known by the name of "natural law," or "law of nature." The Divine law (according to the phraseology just explained) is the standard to which all human laws ought to conform. On the mode of determining this standard some remarks will be made lower down.

Besides positive law, which is known to be a command enforced by a sanction,[†] and the Divine law, which is presumed to be so, there are some classes of laws which are not commands, though they bear an analogy, more or less remote, to laws properly so called. Thus by the term "law of nations," or "international law," are signified those maxims or rules which independent political societies observe, or ought to observe, in their conduct towards one another. An independent political society is a society which is not in the habit of rendering obedience to a political superior; consequently, an independent political society cannot receive a command or be subject to a law properly so called. But inasmuch as the maxims of international morality are general, and determine men's wills by the fear of provoking the hostility of other independent societies against their own country, there is a close analogy between the so-called "law of nations" and positive law.

Other classes of laws not imperative, but having as close an analogy to laws proper as the maxims composing international law, are the "law of honour" and the "law of fashion;" the laws of certain sports and games also stand in a similar predicament. The term *law* is also employed in certain cases where the analogy to laws properly so called is much more remote. Instances of this usage are such expressions as the "laws of motion," the "law of attraction or gravitation," the "law of mortality" in a given country, the "law of population," the "laws of human thought," the "law of a mathematical series." In laws of this class (which may be styled "metaphorical laws") there is no command and no intelligence to work upon; nothing more is signified than that there is a certain uniformity of phenomena, analogous to the uniformity of conduct produced in men by the operation of a law properly so called. [ANALOGY.]

3. *Species of Positive Law.*—The positive laws of any country, considered as a system, may be divided with reference to their *sources* (or the modes by which they become laws) into *written* and *unwritten*. This division of laws is of great antiquity; the expression *unwritten laws* occurs in Xenophon's 'Memorabilia,' in a conversation attributed to Socrates (iv. 4, 19), in the 'Antigone' of Sophocles (v. 450-7, comp. 'Aristot. Rhet.,' i. 13, 2), in the 'Republic and Laws of Plato' (v. 563 and 793, ed. Steph.), and in Demosthenes ('Aristocrat.,' p. 639, ed. Reisk.). In these passages it appears to signify those rules of law or morality which (being founded on obvious dictates of utility) are nearly common to all countries. Unwritten law, in this sense, corresponds with the *jus naturale* of the Roman lawyers. In the language of the Digests and the Institutes, the terms *written* and *unwritten law* ("jus quod constat ex scripto aut ex non scripto") are used in a more precise manner, to signify those laws which had been promulgated by the Roman legislature in writing, and those rules of law which had been tacitly adopted by the same legislature from usage.[*] For (as it is stated in a passage of the Digests) "since the laws derive their binding force from nothing but the decision of the people, it is fitting that those rules which the people have approved of without reducing them to writing should be equally obligatory. For what difference is there whether the people declares its will by vote, or by its conduct?" (Dig. i. 3. 32.)

Sir William Blackstone, dividing the law of England into "the *lex non scripta*, the unwritten or common law, and the *lex scripta*, the written or statute law," goes at some length into the explanation of unwritten law generally, and the elements of which it is composed, as well as into a specific account of the matter composing the unwritten law of England. (1 Com. p. 63.)

In that passage Blackstone clearly explains that unwritten law is so called, not because it does not exist in writing, but because it was not promulgated by the legislature in a written form. His statement of the sorts of laws severally comprehended by the classes of written and unwritten law in England is erroneous. Written law comprehends not only the statutes made by the parliament or supreme legislature, but also the written regulations issued by subordinate legislatures, as orders in council, and rules of court made by the judges. Unwritten law, moreover, comprehends not only the common law which is administered by the courts styled 'courts of common law,' but also the greatest part of the law styled 'equity,' which is administered by the courts styled 'courts of equity.'

Unwritten law has been called by Mr. Bentham *judge-made law*; a name which correctly denotes the mode by which it becomes law.

It may be remarked that a written law is called *a* law, but that a rule of unwritten law is never called *a* law. This phraseology corresponds to the distinction between *lex* and *jus*, and *gesetz* and *recht*, which was explained above.

Positive laws are also divided, according to their *source*, into laws made by *supreme*, and laws made by *subordinate* legislatures. In other words, laws may be issued by the sovereign legislature, or by functionaries deriving their authority from the sovereign legislature.

The *sources* of law are not unfrequently confounded with its *causes*; in other words, with the facts which induce the sovereign to invest certain maxims with the legal sanction. Thus it is fancied that a rule of customary or consuetudinary law exists as law, by virtue of custom or usage, and not by virtue of the authority of the sovereign or his representative, who has imparted to it a binding force. This subject is clearly explained in Mr. Austin's 'Outline of a Course of Lectures on General Jurisprudence,' pp. 10, 11.

The laws of a state, considered as a system, may be divided, with reference to their *subject-matter*, into *public* and *private*. The division of *jus* into *jus publicum* and *jus privatum* originated with the Roman jurists, and occupies a conspicuous station at the beginning of the Digests and Institutes. No trace of this division exists, as far as we are aware, in any Greek author. *Jus publicum* is defined to be 'quod ad statum rei Romanæ spectat,' 'quod in sacris, in sacerdotibus, in magistratibus consistit.' *Jus privatum* is that 'quod ad singulorum utilitatem pertinet.' The institutional treatises of the Roman lawyers appear to have been confined to *jus privatum*; the Institutes of Justinian do not touch upon *jus publicum*, except in the final chapter *De Publicis Judiciis*, and this chapter is wanting in the Commentaries of Gaius, on which the Institutes of Justinian are mainly founded. Hence it appears that the Roman lawyers included under *jus publicum* not only the powers of the sovereign, and the rights and duties of persons in public conditions, but also criminal law. Their definition of *jus publicum*, however, does not properly include criminal law, and the term, as used by later writers, has not in general this extension. *Publicus* is the adjective of *populus*, and signifies that which belonged to the sovereign body of the citizens; hence *jus publicum* signified that law which concerned the government of Rome, and its magistrates and other functionaries. *Privatus* seems to have meant originally that which was *separated* or *set apart* from any common stock; hence it came to signify that which did not concern directly the *public* or state.

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[*] "Lex nil aliud quam *regula imperans*," says Bacon, 'De Augm. Scient. lib. viii., aph. 83. The word *regula*, or *rule*, is ambiguous: it sometimes signifies a *norma*, maxim, or canon simply; it sometimes signifies a *norma*, maxim, or canon, accompanied with a command. Moreover, it is a metaphor to say that the rule or *norma* itself commands. Bacon's definition would therefore be more precise if expressed as follows:—"Lex est norma summi imperantis."

[†] A sanction is the evil with which any one is visited in consequence of disobedience to a command.

[*] The distinction of law into written and unwritten does not seem to have been regularly made by the Roman jurists; for it does not occur in Gaius, from whose Commentaries the substance of the second title of the first book of the Institutes is borrowed. The distinction in question is introduced, both in the Digests and the Institutes with a reference to the Greek writers, doubtless philosophers.

The formal division of law into public and private is not to be found in the institutional treatises of English law. It is, however, used by Lord Bacon, in his treatise 'De Augmentis,' lib. viii., aph. 80; where he advises that, after the model of the Roman jurists, *jus publicum* should be excluded from institutional treatises.

Sir W. Blackstone, in the first book of his 'Commentaries,' treats of the rights and duties of persons, in their public and private relations to each other (pp. 146, 422). The former branch of this division, which occupies chapters 2 to 13, comprehends *jus publicum*, in its limited sense, which nearly corresponds to the English term 'constitutional law.' The *droit politique* or *constitutionnel* of Mr. Bentham, in his 'Traités de Legislation' (tom. i., p. 147, 325-6, ed. 1802), is also equivalent to *jus publicum*, in its strict sense. (Austin's *Outline*, p. lxvii.)

Positive law is further divided, with reference to its subject, into the *law of persons* and the *law of things*. The Roman jurists, who were the authors of this division, arranged these two classes under the head of *jus privatum*, together with a third, viz., the *law of actions*, or of judicial procedure. A full explanation of this important division is not consistent with the purpose of the present article: a brief and lucid statement will be found in Mr. Austin's 'Outline' already cited, pp. xvi--xviii. The most important conditions or *status*, composing the law of persons, are *public* or *political*, and *private*. The former species includes all persons sharing the sovereign power and all public functionaries; the latter includes the conditions of husband and wife, parent and child, master and servant, guardian and ward, &c. The term *jus publicum*, when used in a precise sense, is equivalent to the former of these species. Sir W. Blackstone, misled by the ambiguity of the Latin word *jus*, has rendered *jus personarum* and *jus rerum* by '*rights* of persons,' and '*rights* of things.' The origin of this portentous blunder is explained in Mr. Austin's 'Outline,' p. lxiii.

Positive law is also divided, with reference to the legal consequences of a breach of legal duty, into *civil* and *criminal*.

Civil law is that department of law in which every breach of a duty may be made the subject of a legal proceeding, for the purpose of conferring on the person wronged a right from the enjoyment of which he is excluded by the defendant, or of obtaining from the defendant compensation for a right violated by him. *Criminal law* is that department of law in which every breach of duty may be made the subject of a legal proceeding instituted by the sovereign or his representatives, for the purpose of inflicting punishment on the person charged with the breach of duty. The scope of a civil action is the redress of the plaintiff, by conferring on him the right, or compensation for the violation of a right, which he claims from the defendant. The scope of a criminal prosecution is to inflict punishment on the defendant for the breach of a legal duty which is imputed to him. *Penal* law is not identical with *criminal* law; for an act or omission may be liable to legal punishment in consequence of an action instituted by a *private person*. The action in English law termed a *qui tam* action is partly a civil and partly a penal, but is in no respect a criminal action. By the *civil law*, in England, is commonly understood the Roman law generally, or that portion of it which is received in the ecclesiastical courts.

Law is sometimes opposed to *equity*. *Equity*, in this sense, implies an arbitrary or discretionary power in the tribunal to decide, not according to prescribed rules of law, but according to its own conceptions of moral justice. In the language of the English law, *common law* is opposed to *equity*, concerning which opposition see EQUITY. *Common law* is so denominated as being founded on usages common to the whole nation, and not peculiar to a certain district. (1 Blackst. 'Comm.' p. 67–8.) In like manner, "the Book of *Common* Prayer" is so designated in order to distinguish it from forms of prayer intended for *private* devotion. It may be remarked, that, in the language of the Roman law, *jus civile* is opposed to *jus prætorium* (the law made by the judicial legislation of the prætors), in the same manner that, in the language of the English law, *common law* is opposed to *equity*.

A *law* is likewise opposed to a *privilegium*. *Privilegium* is an ancient term of the Roman law, inasmuch as it occurred in the Twelve Tables. (Cicero, 'Leg.' iii. 19.) It signified, according to its etymology, a measure directed at a single person (*hominem privum*), as distinguished from a law which applies to *classes* of persons; for it is stated in a fragment of Ulpian preserved in the Digests, "jura non in singulas personas, sed generaliter constituuntur." (D. i. 3. 8.) The latter part of the word *privilegium* is connected with *lex*; but we have already stated that *lex* originally did not necessarily signify a rule. More properly, however, a *privilegium* signifies a special command of the sovereign, not founded on an existing general command or law. Such a *privilegium* may either be beneficial to the person or persons affected by it, as an exemption from all personal actions which the king of England can (or could) grant by his *writ of protection* (Blackst. 3 'Com.,' p. 289); or it may deprive him of some of his rights, or inflict some punishment upon him. The difference between a law and a *privilegium* is explained by Sir W. Blackstone as follows:—"Municipal (that is, positive) law is a *rule*; not a transient sudden order from a superior to or concerning a particular person, but something permanent, uniform, and universal. Therefore a particular act of the legislature to confiscate the goods of Titius, or to attaint him of high treason, does not enter into the idea of a municipal law; for the operation of this act is spent upon Titius only, and has no relation to the community in general; it is rather a sentence than a law. But an act to declare the crime of which Titius is accused shall be deemed high treason; this has permanency, uniformity, and universality, and therefore is properly a rule" (or law). (1 'Com.,' p. 44.) The distinction here adverted to is that meant by the Greek writers when they speak of governments administered according to law, and governments administered not according to law. (See particularly Aristotle, 'Polit.,' iv., 4, 5.) In the latter class of states, the acts of the government were a succeession of *privilegia* (generally styled by the Greeks *ψηφίσματα*, although *ψηφίσματα* were often *laws*, strictly so called). Montesquieu's distinction between monarchy and despotism is founded upon the same principle. ('Esprit des Lois,' ii. 1.) Government by *privilegia* is properly called *arbitrary* government, the government being administered not according to rules, but according to the *arbitrium* of the sovereign one or many.

Concerning the difference between the making of laws and the execution of them, or (as they are termed) the *legislative* and *executive* functions of government, see LEGISLATION.

Law is sometimes opposed to *fact*; that is to say, the rule of law is distinguished from the facts or events to which it is applied in practice. In this sense it is said that every one is presumed to know the law; whereas ignorance of the fact is an excuse. (For the doctrines of the Roman law on this subject, see 'Dig.' 22. 6.) The distinction between law and fact is important in our system of jurisprudence, with reference to trial by jury; for, according to the theory of our law, the judge decides concerning the law, and the jury concerning the fact. This maxim is, however, little more than theory; for in practice the jury, by its power of returning a general verdict, is judge both of the law and the fact. [JURY.] (See Best on 'Evidence,' 3rd edit. p. 103.)

Laws, considered singly, have been divided into numerous species, as declaratory, remedial, penal, repealing, &c., laws. Concerning these see Austin's 'Province of Jurisprudence,' p. 22, and Dwarris on 'Statutes,' ch. 10.

4. *Origin and End of Positive Law.*—It has been above stated that all positive laws are commands, direct or indirect, of the person or persons exercising supreme political power in an independent society. Consequently the notion that positive laws are derived from a compact between sovereign and subjects (styled the *original* or *social contract*) is a delusion.

The proper end of positive law is the promotion of the temporal happiness, or well being, of the community over which the law extends. Thus Aristotle, in his 'Politics,' says that "political society was formed in order to enable men to live, and it continues to exist in order that they may live happily." (I. 2.) "Finis et scopus (says Lord Bacon) quem leges intueri atque ad quem jussiones et sanctiones suas dirigere debent, non alius est quam ut *cives feliciter degant.*" ('De Augm.,' lib. viii., aph. 5.) The meaning of Aristotle and Bacon, in the passages just cited, was no other than that expressed by Mr. Bentham in his well-known formula, that the end of political government is "the greatest happiness of the greatest number."

We have stated that the proper end of positive law is the promotion of the *temporal* happiness of the community. The end of the political union is the promotion of the happiness of its members in the present state of existence; that is to say, in the existence which is comprehended between birth and death. The promotion of men's happiness in the existence which commences after death is the end of the religious or ecclesiastical union. (See Warburton's 'Divine Legation,' b. 1, s. 2, vol. i., p. 215, 8vo ed.)

From the benevolence of the Deity, it is presumed that those rules which tend the most to produce the happiness of his creatures are most agreeable to him; and consequently the term "Divine law" (also called natural law) is used to signify those maxims to which human laws ought to conform. In the vast countries where the Mohammedan and Brahminical religions prevail, a great proportion of the positive law is supposed to be derived from the direct revelation of a supernatural being; and therefore the Divine law and the positive laws of the state in great measure coincide. The Christian dispensation, however, does not (like the Jewish) contain any system of rules out of which a body of positive law can be formed, or which can be enforced by a civil government. Consequently, in Christian countries a very small part of positive law is founded upon precepts derived from immediate revelation: the far greater part of positive law is or ought to be fashioned upon rules of Divine law, which are only discoverable by a process of inference from the phenomena of human society.

LAW, CRIMINAL. The object of the English, as of every other system of criminal law is the prevention of injuries by the terror of punishment. But it is not every injury the commission of which the law thinks fit to prevent by such means; in most cases it is satisfied with the redress of injuries after they have been committed, by either restoring the party injured to his right, where that is possible, or by giving him compensation in damages. In law, an injury is any violation of a legal right or omission of a legal duty: a crime, then, may be defined to be such a violation of a legal right or omission of a legal duty as subjects the person guilty of it to punishment. Such acts or omissions for which the law affords redress only have, in England, been usually denominated civil injuries as contradistinguished from crimes. It is to be observed, however, that, in strictness, every crime includes an injury, in respect of which some individual or the public may be entitled to redress. In felony, indeed, such injury is said to be merged in the crime; but this doctrine appears to have originated in the circumstance of all felonies having, with one or two exceptions, been originally punishable with death and having worked a forfeiture of all the offender's property, and so rendered redress impossible.

Crimes, according to the English law, are divisible into two great classes, which depend upon the mode of proceeding peculiar to each, namely, into—

1. Such as are punishable on indictment or information (the common law methods of proceeding).
2. Such as are punishable on summary conviction before a justice or justices of the peace or other authorised persons, without the intervention of a jury (a mode of proceeding derived entirely from special statutory enactments).

It is proposed, in the first place, to treat of offences punishable on indictment or information, and afterwards to shortly refer to those punishable on summary conviction.

Offences punishable on Indictment or Information.

Indictable offences are distributable into four classes or divisions—namely, treasons, præmunires, felonies, and misdemeanors. Persons who commit the offences which constitute the last-mentioned division may also be prosecuted by criminal information instead of being indicted.

The distinction between these classes is for the most part a merely arbitrary one, without any apparent reference to rule or principle, the consequence of which is, that offences in their nature wholly undistinguishable are, in many instances, separated and subjected to punishments widely disproportionate, and to forms of procedure widely dissimilar. In fact, the only real distinguishing feature between one class of crimes and another, at the present day, is to be found in certain peculiarities of punishment and procedure incident to each. Formerly, however, the classes of crimes were marked by distinctive characteristics; but they have subsequently, either by artificial constructions of the courts or by legislative enactments, been made to embrace offences of a very different nature from those originally included within them. For instance, the crime of treason, whether high or petit, implied a violation of the allegiance due from an inferior to a superior. In the case of high treason, so called "by way of eminent distinction," it was the violation of the allegiance due from a subject to his liege lord and sovereign; and in case of petit treason, which was limited to the murder of a husband by his wife, a master by his servant, or an ecclesiastic by his inferior who owed him faith and obedience, it was the breach of the allegiance of private and domestic faith.*

The characteristic above pointed out can no longer be traced in many of the various constructive treasons which have been from time to time created by the courts. It will be sufficient here to give a single illustration of the mode in which the law of treason has been stretched to reach cases totally inconsistent with its original design. By one of the clauses of the statute of treasons (25 Edw. III. c. 2) it is declared to be treason *to levy war against the king*. A riotous assembly attempting by force to redress a public grievance—as, for example, to pull down *all* inclosures or to burn *all* meeting-houses—has been held to be *a levying of war* within the meaning of this clause, although there has been no direct intention or design whatever against either the state or the person of the king. This construction is said to depend upon the *generality* of the design. If the intention be to pull down *particular* inclosures or meeting-houses only, the offence is a mere riot, and in quality a simple misdemeanor. Although the generality of the design may be a reason for awarding a higher punishment in the former than in the latter case, there appears to be no foundation in reason or principle for construing an offence, which but for such generality would be a misdemeanor only, to amount to the crime of treason in levying war against the king.

Again, the term "præmunire" was originally applied to offences which consisted in the introduction of any foreign jurisdiction, more especially the authority of the see of Rome, into the kingdom, but has subsequently, to use the language of Mr. Serjeant Hawkins ('Pleas of the Crown,' b. 1, c. 19), "been applied to other heinous crimes, for the most part having relation to the offences originally coming under the notion of præmunire, but in some instances none at all." The Habeas Corpus Act (31 Car. II. c. 12) contains an instance of the latter mode of application. By the 12th section of that Act it is made a præmunire to send any inhabitant of England, Wales, or the town of Berwick-upon-Tweed, a prisoner beyond the seas in defiance of its provisions to the contrary.

The term "præmunire" was adopted from the first word of the original writ on which the subsequent proceedings were founded: "*Præmunire* (for *præmoneri*) *facias* A. B. quod sit coram nobis," &c. [PRÆMUNIRE.] The Criminal Law Commissioners proposed to abolish præmunires as a class of crimes. (Seventh Report.)

The crime of felony had its origin in very remote times, and was founded upon feudal principles. Its incidents were not formerly, as they are now, of a mere arbitrary nature, peremptorily annexed to certain criminal acts without reference to rule or principle. The crime originally consisted in a violation of the feudal contract by the misconduct of the lord or of the tenant; and where committed by the tenant, occasioned as a consequence the forfeiture of his feud to the lord. (4 Black. 'Comm.,' p. 96; 4th and 7th 'Repts. of Crim. Law Commrs.')

Those crimes, therefore, which induced such forfeiture, and, by a small deflection from the original sense, those which induced the forfeiture of goods also, were denominated felonies; and afterwards, by long use the term *felony* came to signify the actual crime itself, and not the penal consequence. "So that upon the whole," to use the words of Mr. Justice Blackstone (4 'Comm.,' p. 95), "the only adequate definition of felony seems to be that which is before laid down, namely, an offence which occasions a total forfeiture of either lands or goods, or both, at the common law; and to which capital or other punishment may be superadded according to the degree of guilt." Where the punishment is less than capital, the offender loses his goods only; where capital, his lands as well as his goods. The crimes which occasioned such forfeiture were originally, with one or two exceptions, capital; but at the present day there are offences for which no greater punishment can be inflicted than imprisonment for a term not exceeding three years, which are felonies, and consequently occasion the forfeiture of all the offender's goods and chattels; whilst other crimes, for which the punishment may be as high as penal servitude, are misdemeanors only, and work no forfeiture. It is apparent from this that the present law is very defective, and that the amount of punishment is no longer the test of distinction between a felony and misdemeanor. It was proposed by the Criminal Law Commissioners ('Seventh Rep.' p. 16) to remedy this by making the liability to transportation the test of distinction, that is, that all offences liable to a less punishment than transportation should be misdemeanors only.

The term "Misdemeanor" is used in the English system of Criminal Law to denote such indictable offences are of a lower degree than felony.

We shall now point out the peculiarities of punishment which distinguish one class of crimes from another at the present day. In order to this, the penal consequences incident to the whole body of offences constituting each class will be first stated, and then in what respects those consequences differ from each other. The classes will be taken in the same order as above.

Treasons.—Treasons, with one exception mentioned below, are capital; but whether capital or not, the offender, *upon conviction*, forfeits to the crown the personal estate of every description, whether in action or possession, or settled by way of trust, which the offender has otherwise than as an executor ('Cro. Car.' 566), or a trustee, or a mortgagee (13 & 14 Vict. c. 60.) at the time of conviction; and in the case of capital treasons, *upon attainder by judgment of death or outlawry*, the blood of the offender is corrupted, but not so as to obstruct descents to such offender's posterity, when they are obliged to derive a title through such offender to a remoter ancestor (3 & 4 Will. IV. c. 106, s. 10), and all the freehold lands and tenements of inheritance in fee-simple or fee-tail, and all other hereditaments (except copyholds), whether in possession, reversion, or remainder; and all the rights of entry on freehold lands and tenements which the offender has (otherwise than as a trustee or mortgagee, at the time of the offence committed or at any time afterwards), and also the profits of all freehold lands and tenements which the offender has in his or her own right for life, so long as such interest shall subsist, and, if the offender be a male, his wife's dower, are forfeited to the crown (4 Black. 'Comm., 381; 26 Hen. VIII. c. 13, s. 5; 33 Hen. VIII. c. 20, s. 2; and 5 & 6 Edw. VI. c. 11, ss. 9 & 13); and all the copyhold estates belonging to the offender at the time of the offence committed are forfeited to the lord of the manor ('Com. Dig.' Copyhold (M) I.). The above penal consequences are general to all capital treasons, unless, as is sometimes the case, the act which creates the particular treason expressly exempts from some of them. The before-mentioned non-capital treason renders the party guilty of it liable to those only of the above consequences which accrue upon conviction, since the others follow only upon the party's being attainted, that is, sentenced to death or outlawed, which latter, in the case of capital treasons and felonies, is of the same effect as being sentenced to death. The existence of this non-capital treason would appear to be the result of inadvertence. By the Forgery Consolidation Act (11 Geo. IV. & 1 Will. IV. c. 66) it was declared to be treason and punishable with death to forge the great and other royal seals and the sign manual. By the 2 & 3 Will. IV. c. 123, the punishment of death was repealed for forgery in all but the two cases of wills and powers of attorney to transfer stock (it has been since taken away in these cases also by the 7 Will. IV. & 1 Vict. c. 84); but the *quality* of the offences enumerated in the Forgery Consolidation Act was left without alteration; so that to forge the royal seals, &c, would appear to be still treason, though no longer a capital offence.

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* Petit Treason was abolished by the 9 Geo. IV. c. 31, s. 2, and the offences constituting it declared to be murder only.

The judgment of death in the case of treason is that the offender, if a male, be drawn on a hurdle to the place of execution, and be there hanged by the neck until dead; and that afterwards the head be severed from the body of such offender, and the body be divided into four quarters, to be disposed of as her Majesty shall think fit (54 Geo. III. c. 146); and, if a female, that the offender be drawn to the place of execution and be there hanged by the neck until dead (30 Geo. III. c. 48, s. 1). The queen, however, may, by warrant under her sign manual, countersigned by a principal secretary of state, direct, where the offender is a male, that he shall not be drawn, but taken in such manner as in the warrant shall be expressed to the place of execution, and that he shall not be hanged, but be beheaded, whilst alive, instead (54 Geo. III. c. 146, s. 2).

2. *Præmunires.*—The penalties of præmunire, as shortly summed up by Sir Edward Coke (1 'Inst,' 130 a.), are, "that from the conviction the defendant shall be out of the king's protection, and his lands and tenements" (that is, in fee-simple or for life, but not in tail beyond his life interest therein), "goods and chattels, forfeited to the king: and that his body shall remain in prison at the king's pleasure, or, as other authorities have it, during life." These penalties were first imposed by the stat. 16 Rich. II. c. 5 (commonly called the Statute of Præmunire); and it is by reference to that statute that all subsequent præmunires have been made punishable. It was formerly supposed that a person convicted of præmunire, being put out of the king's protection, might be killed with impunity, as being the king's enemy; but by the 5 Eliz. c. 1, ss. 21 and 22, it was enacted that it should not be lawful to kill any person attainted in a præmunire, saving such pains of death or other hurt or punishment as theretofore might, without danger of law, be done upon persons sending or bringing into the realm, &c., any process, &c., from the See of Rome. The statute of Elizabeth was, however, repealed by the 9 & 10 Vict. c. 59. Præmunires, although they occasion a forfeiture of the offender's lands and goods, are not felonies. To constitute a felony the offence must have worked a forfeiture at the common law; but in the case of præmunire the forfeiture is made a part of the punishment by statute merely, which is not sufficient. (4 Black. 'Comm.,' pp. 94 and 118.)

3. *Felonies.*—All felonies, as stated above, were originally, with one or two exceptions, punishable with death; but the offender, unless the felony was excluded from the benefit of clergy, was entitled for a first offence, to be discharged from the capital punishment upon praying that benefit. [BENEFIT OF CLERGY.] But now, since the passing of the 7 & 8 Geo. IV. c. 28, no felony is punishable with death unless it was excluded from the benefit of clergy before or on the 14 Nov. 1826, or has been or shall be made punishable with death by some statute passed since that day. Where not capital, felonies are punishable either in the manner prescribed by the statute or statutes specially relating to such felonies, or, where no punishment has been or may hereafter be specially provided, with penal servitude for seven years, or imprisonment for any term not exceeding two years, with the addition, if the court shall think fit, of whipping, where the offender is a male, hard labour and solitary confinement, or any of them. (7 & 8 Geo. IV. c. 28, ss. 7 and 8.) Such confinement must not, however, be for a longer period than one month at a time, or three months in a year. (7 Wm. IV. & 1 Vict. c. 90, s. 5.) In the case of *all* felonies, whether capital or not, the offender immediately *on conviction* forfeits to the crown all the personal estate of every description, whether in action or possession, or settled by way of trust, which he has otherwise than as an executor ('Cro. Car.' 566), or a trustee or mortgagee (13 & 14 Vict. c. 60), at the time of conviction (Bac. 'Abrid.,' "Forfeiture" (B); Co.-Litt. 391 a); and in the case of all capital felonies, *upon attainder by judgment of death or outlawry*, forfeits to the crown the profits of all estates of freehold (4 Black. 'Comm.,' 385), and of things not lying in tenure (Bac. 'Abrid.,' "Forfeiture" (A)), and to the lord of the manor the profits of all estates of copyhold (Hawk. 'P. C.' b. 2, c. 49, s. 7; Lord Cornwallis's case, 2 Vent. 38–9), which the offender has, otherwise than as a trustee or mortgagee (13 & 14 Vict. c. 60), at the time of the offence committed, during his life; and his blood is corrupted (but not so as to obstruct descents to the posterity of such offender where they are obliged to derive a title through him to a remoter ancestor (3 & 4 Will. IV. c. 106, s. 10), and after his death his copyholds which he holds in fee-simple are forfeited to the lord of the manor. (Scriven 'On Copyholds,' 523, note (d).) And also in the case of murder, all his freehold lands and tenements in fee-simple escheat (subject to what is called the crown's year, day and waste) to the lord of the fee. (54 Geo. III. c. 145; Co.-Litt. 391 a; 4 Black. 'Comm.' 385.) The Court of Chancery may appoint a new trustee in the place of a trustee convicted of felony, and may make an order vesting the estate in the new trustee. (15 & 16 Vict. c. 55, s. 8.)

The judgment of death in the case of all capital felonies, except murder, is that the offender be hanged by the neck until dead (2 Hale's 'P. C.' 411); and, in the case of murder, it is the same, with the addition that the offender's body shall be buried within the precincts of the prison in which he shall have been confined after conviction. (2 & 3 Will. IV. c. 75, s. 16; 4 & 5 Will. IV. c. 26.) The court however is empowered, if it shall think that the offender is a fit subject to be recommended to the royal mercy, to abstain from pronouncing judgment of death upon him, and to order such judgment to be entered of record instead; and the judgment so recorded has the same effect as if pronounced and the party were reprieved. (4 Geo. IV. c. 48, ss. 1 and 2; 6 & 7 Will. IV. c. 30, s. 2.)[*]

The following felonies are still punishable with death:—

1. Destroying ships of war or her majesty's arsenals, dock-yards, naval, military or victualling stores, or other ammunition of war, &c. (12 Geo. III. c. 24, s. 1.)
2. Murder. (9 Geo. IV. c. 31, s. 3.)
3. Unnatural offences. (9 Geo. IV. c. 31, s. 15.)
4. Attempts to murder by administering poison, or by wounding, or by any other means where bodily injury dangerous to life is caused. (7 Wm. IV. & 1 Vict. c. 85, s. 2.)
5. Burglary, aggravated by striking an inmate. (7 Wm. IV. & 1 Vict. c. 86, s. 2.)
6. Robbery, aggravated by wounding the person robbed. (7 Wm. IV. & 1 Vict. c. 87, s. 2.)
7. Piracy, aggravated by endangering the life of any person on board of the vessel in respect of which the piracy is committed. (7 Wm. IV. & 1 Vict. c. 88, s. 4.)
8. Setting fire to a dwelling-house, any person being therein. (7 Wm. IV. & 1 Vict. c. 89, s. 2.)
9. Destroying vessels with intent to murder, or whereby human life is endangered. (7 Wm. IV. & 1 Vict. c. 89, s. 4.)
10. Exhibiting false lights, &c. with intent to bring ships into danger, or unlawfully doing anything tending to the destruction of ships in distress. (7 Wm. IV. & 1 Vict. c. 89, s. 5.)

Besides the above offences, that of wilfully and without lawful excuse having or being possessed of any forged stamp used in pursuance of any Act relating to any duties on gold or silver plate made or wrought in Great Britain, for the purpose of marking or stamping such plate, appears to be still punishable with death.

That offence is contained in 55 Geo. III. c. 185, s. 7, by virtue of which enactment it was formerly also a capital crime to forge or utter the stamps provided for marking any such plate, or to fraudulently remove such stamps from one piece of such plate to another, or privately and secretly to use such stamps with intent to defraud the king. The punishment of death for these last-mentioned offences was repealed, however, by 11 Geo. IV. & 1 Wm. IV. c. 66, s. 1 (as to the forging and uttering), and by 4 & 5 Vict. c. 56, s. 1 (as to the removing and fraudulently using); but by some inadvertence (for it is clear that it can never have been intended) the offence of being possessed, without lawful excuse, of forged stamps for marking gold or silver plate (the least criminal of all the acts specified in 55 Geo. III. c. 185, s. 7) is still left capital.

There are two other enactments of capital offences, which also do not appear to have been repealed. The 2 Geo. II. c. 25, s. 2, and the 12 Geo. III. c. 48, s. 1, make it capital for offenders convicted under the provisions of those statutes, to escape or break out of prison; and these enactments do not seem to have been wholly repealed, either expressly or by implication. The Criminal Law Commissioners (7th Report) say, "Although many Acts have been passed which punish prison-breach by penalties not capital, yet these seem to be confined to particular gaols and prisons, and not to affect the general enactments above referred to, as regarding offenders against their provisions confined in other prisons."

4. *Misdemeanors.*—The punishment in the case of misdemeanors, where none is specially provided by statute, is generally fine and imprisonment. The statutable punishments vary from transportation for life (for which penal servitude has been substituted) to fine or imprisoment.

From what has been stated, it will be seen that the circumstance, so far as punishment is concerned, which distinguishes misdemeanors from all the other classes of offences, is the absence of forfeiture as a necessary consequence of conviction. The distinction between præmunires and felonies (which term, it should be remarked, in its largest sense, includes treasons, on account of the forfeiture which that class of crimes occasions) is, that the forfeiture which ensues upon a conviction of the former is, as before observed, in pursuance of statutable provisions; whereas in the latter case it is a common law consequence of the offence, and follows as a matter of course whenever a crime is declared to be a felony. There appears to be no distinction as regards punishment, independently of special statutable enactment, between non-capital felonies (the term is used here in its ordinary restricted sense) and the non-capital treason above described; but the difference between felonies and treasons when punishable with death is very considerable. In the case of felonies the offender, upon attainder, *forfeits* to the crown the profits only of such freehold and copyhold lands as he had at the time of committing the offence, during his life, and after his death, his copyholds in fee-simple are forfeited to the lord of the manor; and even where attainted of murder, though his freehold estates in fee-simple fail after his death, it is not as a consequence of the law of forfeiture, but because they escheat for want of heirs capable of succeeding to them, owing to his blood being corrupted by the attainder; and it is on account of such estates escheating and not being forfeited that they go to the lord of the fee (that is, subject to the crown's year, day and waste), and not to the crown, unless there appears to be no intermediate lord between the offender and the crown, in which event the crown takes as ultimate lord of the fee. In the case of treason, however, the offender upon attainder, instead of forfeiting to the crown the profits merely of such freehold lands as he had at the time of committing the offence, during his life, forfeits all freehold estates of inheritance, as well those in fee-tail as those in fee-simple, and not only such as he had at the time of the commission of the offence, but those also which he may acquire at any time afterwards; and instead of forfeiting to the crown the profits of his copyholds during his life, and to the lord of the manor his copyholds in fee-simple only, he forfeits at once to the lord of the manor *all* the copyholds belonging to him at the time the offence was committed. Where the offender is a male, his wife's dower is also forfeited to the crown, which is not the case in felony. It is to be observed that the crown is empowered (see 59 Geo. III. c. 94) to restore the whole or any part of any lands or hereditaments to which it becomes entitled by escheat or forfeiture to the family of the offender, a provision which has greatly mitigated the harshness of the law of forfeiture. The Criminal Law Commissioners however recommended the entire abolition of the confiscation of property as a necessary incident to convictions for treason or felony ('Seventh Report on Criminal Law'). No forfeiture follows a summary conviction for felony under the Juvenile Offenders act (10 & 11 Vict. c. 82). The difference between the judgment of death for treason and that for felony requires no comment.

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[*] See R. *v.* Hogg, 2 M. & Ro., 381, where it was held that since the passing of the 6 & 7 Will. IV. c. 30, death may be recorded in the case of murder as well as other capital felonies, notwithstanding the exception contained in the 4 Geo. IV. c. 48.

Besides the above peculiarities of punishment, these different classes of offences are distinguished by particular forms of procedure; but it will be more convenient to refer to these when describing our general system of criminal procedure.

According to the law of England, all persons above the age of seven years, except such as by reason of unripeness, weakness, unsoundness, disease, or delusion of mind, are incapable of discerning, at the time they do an act, that the act is contrary either to the law of God or the law of the land, are criminally responsible for such act; but temporary incapacity wilfully incurred by intoxication or other means is no excuse. An infant of the age of seven and under fourteen years, however, is to be presumed to be incapable of committing a crime until the contrary be proved. Duress, also, inducing a well-grounded fear of death or grievous bodily harm, will excuse a person acting under such duress in all cases except treason and murder; and a married woman committing any offence, except those last mentioned, if her husband be present at the time, shall be presumed to have acted under his coercion, and be entitled to an acquittal, unless it appears that she did not so act. A married woman also shall not be liable to conviction for receiving her husband or any other person in his presence and by his authority.

The whole of the law, written as well as unwritten, relating to the definition and punishment of offences, that is, the whole Criminal Law of England as regards indictable crimes and their punishments as it then existed, was collected and reduced into one body by the Criminal Law Commissioners (see their 7th Report), and was thus for the first time rendered accessible to the public at large. Before this reduction the Criminal Law had to be sought for in an immense mass of statutes, reported decisions, records, ancient and modern, and text-books; and, on that account, could be known but to the few, and those principally engaged in the practice or administration of the law. The digest so prepared by the Commissioners, and called by them 'The Act of Crimes and Punishments,' was comprised in twenty-four chapters, under the following heads:—

1. Preliminary Declarations and Enactments.
2. Treason and other offences against the State.
3. Offences against Religion and the Established Church.
4. Offences against the Executive Power generally.
5. Offences against the Administration of Justice.
6. Offences against the Public Peace.
7. Offences relating to the Coin, and to Bullion, and Gold and Silver Plate.
8. Offences relating to the Public Property, Revenue, and Funds.
9. Offences against the law of Marriage.
10. Offences relating to Public Records and Registers.
11. Offences against Public Morals and Decency.
12. Offences against Public health.
13. Common Nuisances.
14. Offences relating to Trade, Commerce, and Public Communication.
15. Homicide and other offences against the person.
16. Libel.
17. Offences against the Habitation.
18. Fraudulent Appropriations.
19. Piracy and Offences connected with the Slave Trade.
20. Malicious Injuries to Property.
21. Forgery and other offences connected therewith.
22. Illegal Solicitations, Conspiracies, Attempts, and Repetitions of Offences.
23. Definitions of Terms and Explanations.
24. Chapter of Penalties.

Upon the subject of punishments, the Commissioners recommended the abolition of forfeiture as an incident to convictions for treason or felony; were inclined to reject whipping as a mode of punishment, except in the case of discharging or aiming fire-arms, &c., at the queen (5 & 6 Vict. c. 51, s. 2), in which it has lately been imposed by the legislature as constituting a signal mark of ignominy; proposed that three, or at the utmost four, years should be the longest term of imprisonment to be inflicted for any offence, whether treason, felony, or misdemeanor, in cases where imprisonment forms the whole or part of the punishment; and suggested a scale of penalties, consisting of forty-five classes, to be substituted for the numerous punishments contained in the above statement. This scale might be much further reduced if the recommendations of the Commissioners should be adopted. At present it is extremely difficult in some instances to determine what punishment an offence is liable to.

A bill embodying the provisions of the 'Act of Crimes and Punishments,' subject to such omissions as were recommended by the Commissioners, was introduced, at the end of the session of 1844, in the House of Lords by Lord Brougham, but was ultimately withdrawn at the instance of the Lord Chancellor, who undertook to issue a commission for the purpose of revising it, that duty being too laborious for any government to grapple with, and if their report should be favourable to its adoption, to found one or more government measures upon it, as should be thought most expedient. A commission was accordingly appointed for this, amongst other purposes, 1845, but no practical result followed. The members of the old commission made a report containing a digest of the law of procedure as regards indictable offences (a most difficult and laborious undertaking).

Besides the 'Act of Crimes and Punishments,' and the Digest of the Law of Procedure, several other most important reports emanated from the original Criminal Law Commission. It was upon their recommendation that the Acts of the first year of her present Majesty's reign, repealing the punishment of death in the case of between thirty and forty crimes, were founded. It was a report of theirs which mainly contributed to the alteration of that harsh and inconsistent rule of our law which denied a prisoner his full defence by counsel upon a charge of felony. They also made a very elaborate and valuable report upon the Consolidation of the General Statute Law, and a report upon the subject of Juvenile Offenders—in all, the number of reports which issued from the commission between the period of its first appointment in 1833 and its termination in the year 1845 was eight.

A sum exceeding 65,000*l.* has been spent on various commissions, which have been issued during the last thirty years for the consolidation or codification of the criminal law; but that object has not yet been attained, nor have any really practical measures been adopted for such an annual revision of our statutes as would in a few years naturally produce their consolidation, if not a codification of the law itself. It is thought, however, that the well-grounded impatience of the House of Commons cannot much longer delay the passing of general acts consolidating and so far codifying the criminal law; on this ground it is desirable to abstain from any attempt to enumerate those alterations in details which have been made from time to time. One or two points only need be referred to. The summary jurisdiction recently conferred on magistrates in petty sessions is noticed under LARCENY; the liability of trustees to prosecution for breach of duty, under the head TRUSTEES. Great improvements were effected in the procedure of the courts which take cognisance of crimes by the statute 14 & 15 Vict. c. 100, which abolished all technical objections for misnomers or nondescriptions, and invested the judges with ample powers of amendment. A court of criminal appeal in cases involving questions of law has been established. Finally, transportation as a punishment to be ordered by the court has been abolished by the statute 20 & 21 Vict. c. 3. *Penal Servitude*, as it is termed, created by statute 16 & 17 Vict. c. 99, has been substituted; but criminals sentenced to long terms of penal servitude continue to be transported as before.

Procedure.

Where any indictable crime has been or is suspected to have been committed, the ordinary mode of bringing the accused to justice is as follows:—Unless he surrender himself, he is, in the first place, to be summoned by some magistrate, having jurisdiction, to appear before him, or, as is more generally the case, a warrant for his apprehension is to be procured from some such magistrate. In order to the issuing of a warrant there must be an information laid on oath. Instead of a warrant the justice may, in his discretion, and on a mere charge or complaint, without a written information or oath, issue a summons in the first instance. After a summons duly issued and served upon the accused, he is to appear according to its directions, or in default the magistrate may issue his warrant to apprehend him (11 and 12 Vict., c. 42). After a warrant duly granted, whether a summons have been previously issued or not, the person to whom it is directed is to proceed to arrest the accused (and if for treason, felony, or breach of the peace, may do so on any day, and at any time of the day or night), and to take him to jail or before some magistrate having jurisdiction, according to the import of the warrant, and that without any unnecessary delay. It is also lawful for a constable or private person who sees a felony committed, or attempted to be committed, or a dangerous wound given, to arrest the offender, without warrant; also any person whom he reasonably suspects of having committed a felony which has actually been committed, and persons found committing thefts or malicious injuries to property and some other offences, and by the statute, 14 & 15 Vict., c. 18, any one may apprehend a person found committing any indictable offence in the night. A constable may also, without warrant, arrest on a reasonable charge made of a felony committed or dangerous wound given, although it afterwards appear that none such had been actually committed or given; also for a breach of the peace committed in his view; but (except in the case of one of the metropolitan police, who may under certain circumstances do so upon a charge made of an aggravated assault [see 2 & 3 Vict., c. 47]), not for one committed out of his view. Justices of the peace, sheriffs, coroners, and all other peace officers, have, it would appear, the like power to arrest as constables.

On surrendering himself or appearing in obedience to a summons, or being brought before a justice of the peace under a warrant, the justice is to proceed to take the statement on oath of those who know the facts and circumstances of the case, and to reduce those statements into writing, which are then signed by the witnesses and are termed their 'depositions.' These are read to the accused and after being cautioned according to a form provided, he is at liberty to make a statement, which is taken down and transmitted with the depositions to the court, before which the accused is sent for trial. If, however, the justice or justices, are of opinion that the evidence is not sufficient to put the accused party upon his trial for any indictable offence, he is discharged, otherwise, or if the evidence given raise a strong or probable presumption of his guilt, he must either be committed to prison for trial or give bail (see Bail).

Where a party is committed or bailed for any offence, the justice may bind by recognisance all persons who know or declare anything material touching it, to appear and prosecute, or give evidence against him. When held to bail or committed to prison, the accused is entitled to have delivered to him, on demand, copies of the examinations of the witnesses upon whose depositions he is so bailed or committed, on payment of a reasonable sum not exceeding 1½*d.* for each folio of 90 words. (11 & 12 Vict., c. 42)

To the above mode of proceeding there are some exceptions.

Under the Juvenile Offenders Acts (10 & 11 Vict. c. 82, and 13 & 14, c. 37), any two justices of the peace in petty sessions, or any magistrate of the metropolitan police-courts, or any stipendiary magistrate, before whom any person is charged with having committed, or having attempted to commit (or with having been an aider, abettor, counsellor, or procurer in the commission of) any offence by law deemed or declared to be simple larceny, or punishable as simple larceny, may, if the age of such person shall not exceed sixteen years, convict him in open court of such offence, and pass a sentence of imprisonment for any term not exceeding three months, with or without hard labour, or impose a fine not exceeding three pounds. If a male not more than fourteen years of age, he may be once privately whipped, either instead of or in addition to such imprisonment. On the other hand, if the justices consider the charge not to be proved, or if proved, that it is not expedient to inflict any punishment, they may dismiss the accused with or without requiring him to find sureties for his future good behaviour.

The accused person may object to the case being summarily disposed of. In order to ascertain his wish on this point, one of the justices, before asking him whether he has any cause to show why he should not be convicted, must inquire, in words prescribed by the statutes, whether he wishes to be tried by a jury; and if the accused or his parent then objects to a summary trial by the justices, they must proceed with the charge against him as if their summary jurisdiction did not exist. If the charge be dismissed, the dismissal is, equally with a conviction, a bar to any further or other proceedings. By the statute 18 & 19 Vict. c. 126, more extensive powers of summarily convicting offenders were conferred on justices. Where any person is charged before justices of the peace at petty sessions (or any magistrate of the metropolitan police district, or any stipendiary magistrate generally) with having committed simple larceny, and the value of the property does not exceed five shillings, or with having attempted to commit larceny from the person, or simple larceny, the justices may, with the assent of the accused, hear and determine the charge in a summary way. In order to do so, the justices, at the close of the examinations of all the witnesses for the prosecution, must state to the person accused the substance of the charge against him, and then inquire of him, in the language prescribed by the statute, whether he consents that the charge shall be so tried, or sent for trial by a jury. In case of dissent, there is an end of all summary proceedings; but if the accused assents to the charge being disposed of summarily, the justices reduce it into writing; and having read it to the accused, require him to plead thereto. If he says he is guilty, he may be sentenced to three calendar months' imprisonment, with hard labour. If he says he is not guilty, the justices are to hear his defence, and then dispose of the case summarily. On the other hand, if the justices think the charge not proved, they may dismiss it, which has the effect of an acquittal; and even if the justices think the case is legally made out, but that there are circumstances rendering it inexpedient to inflict any punishment, they may dismiss the person charged without proceeding to a conviction.

The summary powers conferred by this statute are not, however, limited to trying offenders in the cases above mentioned; the justices have powers to *punish* in some other cases where the accused admits his guilt. In cases of simple larceny, of stealing from the person, or of larceny as a clerk or servant, irrespective altogether of the value of the stolen property, where the evidence for the prosecution is, in the opinion of the justices, sufficient to put the person charged on his trial, but the case nevertheless appears to them to be one which may properly be disposed of in a summary way, they are to reduce the charge into writing, and having read it to the accused person, to ask him whether he is guilty or not guilty. If he says he is guilty, that plea is entered, and the justices may commit him to jail and hard labour, for any term not exceeding six months; but before the question is put, the justices must explain to the accused that he is not obliged to plead or answer before them at all, and that if he do not so plead or answer he will be committed for trial in the usual course. It must be added, that if it is made to appear that the accused has been previously convicted of felony, the justices have no jurisdiction to dispose of the case summarily.

Before a prisoner can be put upon his trial for any treason or felony, it is necessary that a bill of indictment should be found against him by a grand jury duly returned before some court which has jurisdiction to try parties for crimes by means of a petty jury; or in the case of murder or manslaughter, he may be tried upon the coroner's inquisition. Where the offence with which he is charged is a misdemeanor, he may be tried either upon bill of indictment found, as in the case of treason or felony, or upon a criminal information filed against him in the name of the queen. For a præmunire, he is to be first indicted as in other cases, or may be proceeded against in the peculiar manner pointed out by 16 Rich. II., c. 5, commonly called the Statute of Præmunire. This latter mode may, however, be regarded as obsolete.

A bill of indictment is an accusation at the suit of the Crown, and being for the public benefit and security, may generally be preferred by any person; but it is not usual for parties to interfere unless they are individually aggrieved by the offence, or fill some office which renders it peculiarly incumbent on them to bring the offender to justice; and a recent statute (22 & 23 Vict. c. 17) has taken away the power to prefer indictments for perjury, conspiracy, false pretences, and some other misdemeanors, without the previous committal of the parties by a justice, or the leave of the court. [Indictment.] So soon as the grand jury have presented the bill of indictment in court, indorsed "a true bill," the indictment is complete. If the grand jury find no true bill, the accused, where in custody, is to be at once set at large, without the payment of any fees on account of such discharge (14 Geo. III. c. 20; 55 Geo. III. c. 50; 8 & 9 Vict. c. 114). An indictment may also be framed upon the presentment by a grand jury, of their own knowledge that an offence has been committed; but this mode of prosecution is seldom adopted. For further particulars relating to Grand Juries, see Jury.

A criminal information in the name of the Queen is a suggestion filed on record by the attorney-general or by the queen's coroner or master of the Crown Office, in the court of Queen's Bench, that a misdemeanor has been committed by an alleged offender. The attorney-general, or, during vacancy in that office, the solicitor-general, may at his discretion file a criminal information. In all other cases it is in the discretion of the Court of Queen's Bench to grant or refuse leave to file such informations, and such leave will only be granted on motion made, grounded on proper affidavits, and in respect of misdemeanors of such magnitude or under such circumstances as, in the opinion of the court, call for its interference. After an information is filed, all the subsequent proceedings are, in general, the same as after an indictment found for a misdemeanor.

Persons committed for treason or felony who move in open court the first week of the term, or first day of the sessions of oyer and terminer or jail delivery, to be brought to trial, may, if not indicted some time in the next term or session after their commitment, be bailed by the judges of the Queen's Bench, or justices of oyer and terminer or jail delivery, unless it appear that the witnesses for the crown could not be produced the same term or sessions; and if not indicted and tried the second term or sessions after their commitment, or if acquitted upon their trial, shall be discharged from imprisonment (31 Car. II.. c. 2, s. 7). [Habeas Corpus Act.]

When the indictment is found, in cases of felony, the accused is bound to plead and try *instanter*, and if in custody, is to be brought to the bar and arraigned (which is the legal term for calling on a prisoner to answer to a charge of an indictable offence) as soon as convenient after such indictment is found; but in all cases of treason, except where the overt act is the assassination of the queen, the endangering of her life or person, or any attempt to injure her person (39 & 40 Geo. III. c. 93; 5 & 6 Vict. c. 51), and except the forgery of the great and other royal seals (7 & 8 Wm. III. c. 3, s. 13), the accused is to have a true copy of the indictment delivered to him ten days at the least before he is arraigned, and, *at the same time*, a list of the witnesses to be produced against him, and if indicted in any other court than the Queen's Bench, a list of the petit jury; but if indicted in the Queen's Bench, the list of the petit jury may be delivered to him at any time after his arraignment, so as it be delivered ten days before the day of trial (7 & 8 Wm. III. c. 3, s. 1; 7 Anne, c. 21, s. 11; 6 Geo. IV. c. 50, s. 21). If the accused plead, however, without claiming or having had delivered to him such copy or lists, he will be considered to have waived any objection on account of such non-delivery. If the accused, whether in case of felony or misdemeanor, be not in custody nor on bail when the indictment is found, or, being on bail, make default, his appearance may be compelled by process or by a bench warrant; and he may be prosecuted to outlawry. [OUTLAWRY.] No fee is to be demanded or taken from persons charged with or indicted for felony or misdemeanor, or as an accessory to felony, for their appearance to the indictment or information, or for allowing them to plead, or for recording their appearance or plea, or for discharging any recognisance taken from such persons, or any sureties for them (8 & 9 Vict. c. 114, s. 1).

In cases of treason, the accused is entitled, on application to the court, to have two counsel assigned him, who may have free access to him at all seasonable hours (7 & 8 Wm. III. c. 3, s. 1). The court may also, if it think fit, upon the accused's making affidavit that he is not worth 5*l.* beyond his wearing apparel, allow him to defend *in formâ pauperis;* in which case neither the officers of the court, nor those who are assigned to conduct his cause, may take any fees.

The prisoner, upon being arraigned or charged with the indictment, in cases of felony or misdemeanor, may either confess the charge to be true, in which event such confession is to be recorded and judgment awarded according to law, or may plead to the indictment or demur. By pleading, he puts in issue the facts of the charge; by demurring, he admits the facts, but contends that they amount to no offence indictable by law; as, if a man were indicted for feloniously stealing game, without alleging that it was tame or confined; in which case, upon demurrer, he must be discharged. After demurrer, in cases of felony or misdemeanor, decided against the prisoner, he is not at liberty as a matter of right to plead over "Not Guilty" (Reg. *v.* Faderman, 1 Den. c. c. 569), but the court may permit him to do so. In either case, if the demurrer be decided for the prisoner, the judgment is that he be dismissed and discharged.

The pleas which may be pleaded by a prisoner are either to the jurisdiction of the court, and these must be pleaded before any other plea, or in abatement (now almost unknown), or in bar; and pleas in bar are either special pleas or the general issue. Special pleas may allege a previous acquittal, conviction, or attainder of the same offence, or a pardon [PARDON]; and, in the case of prosecutions for the non-repair of highways or bridges, the liability, if denied by the defendant, of the party who is liable for the repair of the same.

The general issue, or "Not Guilty," which is the plea employed in the infinitely greatest number of cases, puts in issue the whole question of the accused's guilt or innocence of the charge in all its bearings; and not only casts on the prosecutor the burden of making out every part of his charge, but entitles the accused to give in evidence every possible ground of justification or excuse which can form an answer to the indictment.

No advantage can now be obtained by a plea in abatement, as by the 7 Geo. IV. c. 64, s. 19, the court may, upon such plea, immediately cause the indictment to be amended, and call upon the party to plead to it so amended, as if no such plea had been pleaded. In cases of felony, if a special plea be found for the crown, the prisoner may plead over "Not Guilty;" but in cases of misdemeanor, the judgment for the crown is final. In either case, if it be found for the prisoner, he is to be dismissed.

If, instead of pleading, the prisoner stand mute of malice, or will not answer directly to the indictment, the court may order a plea of "Not Guilty" to be entered on his behalf, and such plea will have the same effect as if it had been actually pleaded by him (7 & 8 Geo. IV. c. 28, s. 2). But if a doubt arise whether he be mute of malice or dumb, a jury is to be impanneled to try the fact, and, if the latter be found, the court will use means to make the prisoner understand what is required of him; but if this be impossible, will direct a plea of "Not Guilty" to be entered, and the trial to proceed. Should he upon arraignment be found to be insane by a jury impanneled for the purpose under the provisions of the 39 & 40 Geo. III. c. 94, so that he cannot be tried, the court may order such finding to be recorded and the prisoner to be kept in strict custody until her Majesty's pleasure be known.

When, however, the plea of "Not Guilty" has been pleaded, the trial is to be had before some court having jurisdiction, by twelve jurors, generally of the county where the fact is alleged in the indictment to have been committed, called a petit jury, by way of distinction from the grand jury. The ordinary courts having jurisdiction to try indictable offences are the Queen's Bench, the Central Criminal Court, Courts of Oyer and Terminer, Gaol Delivery, and Quarter-Sessions Borough Courts and the Superior Criminal Courts of the Counties Palatine; but Courts of Quarter-Sessions and Borough Courts have no jurisdiction with respect to treason or any felony punishable with death or transportation for life, or several other offences (5 & 6 Vict. c. 38, s. 1). The trial is generally to be had in the county or district in which the offence was committed.

Upon the trial being called on, the jurors are to be sworn as they appear, to the number of twelve, unless they be challenged. As to challenges, whether on the part of the crown or the prisoner, and as to petit juries generally, see JURY. It may here be observed, however, that the right of peremptory challenge, that is, of challenging at mere pleasure, without showing any cause, which exists in cases of treason and felony, is one of the peculiarities before alluded to, which distinguish those classes of crime from misdemeanors; and that the power to challenge peremptorily to the number of thirty-five jurors in cases of treason, and to the number of twenty only in cases of felony, is a distinguishing feature between treasons and felonies. When twelve jurors are procured free from exception, and have been sworn, or, if Quakers, Moravians, or Separatists, or persons who have been Quakers or Moravians, have made their solemn affirmation, in case of treason or felony, well and truly to try and true deliverance make between the queen and the prisoner whom they have in charge, and, in cases of misdemeanor, well and truly to try the issues joined between the queen and the defendant, the case, where counsel is retained for the prosecution, is to be opened by him, or, if two or more counsel are retained, by the leading one, according to his instructions, unless the case is so plain as not to require any statement. The counsel for the prosecution ought, however, to confine himself, so far as possible, to a simple statement of the facts which he expects to prove, and to abstain from any appeal to the passions of the jury, more particularly in cases where the prisoner has no counsel. After the opening, or, where no counsel is engaged for the prosecution, immediately after the swearing of the jury, the examination of the witnesses on behalf of the Crown commences. Before being examined an oath or affirmation is administered to each witness "that he will true answer make to such questions as the court shall demand of him, and will tell the truth, the whole truth, and nothing but the truth." Where there is counsel, he examines the witnesses; where there is none, that duty devolves on the court. In criminal cases a single witness, swearing to the actual offence, or to such facts as necessarily lead to the inference that it has been committed, if believed by the jury, is generally sufficient to substantiate the charge. In treason, perjury, and the offences of tumultuously petitioning, affirming that parliament has a legislative authority without the crown, or that any person is entitled to the crown contrary to the Act of Settlement, and blasphemy under the provisions of 9 & 10 Wm. III. c. 32, however, there must be two witnesses. In all cases, also, the prisoner's confession, if made in consequence of a charge against him, and in a direct and positive manner, voluntarily and without promise or threat operating on his mind at the time of making it, is sufficient, even if there be no other proof that the crime with which he is charged has been committed, for the jury to convict upon, if they believe it to be true. And the single unsupported testimony of an accomplice is sufficient (except where two witnesses are required), if the jury believe his story; but it is usual in such cases for the court to direct the acquittal of the prisoner. If, however, the accomplice be corroborated by unsuspicious evidence as to such parts of his testimony as show that his story has not been fabricated, the court will not interfere.

There are four kinds of proof by which criminal charges may be sustained: 1, *positive*, as by the direct testimony of a witness who saw the fact; 2, *circumstantial*, when a number of facts are presented which are inconsistent with any other hypothesis than that of the prisoner's guilt; 3, *presumptive*, as when the possession of a stolen article casts on the prisoner the burden of showing how he obtained it; 4, *confessional*, where the prisoner makes a voluntary admission of his guilt, as already mentioned. The general rules of evidence in criminal proceedings are the same as those which are applicable in civil cases. [EVIDENCE.] A husband or wife of an accused person, however, cannot be a witness for or against each other (unless upon a charge of criminal violence done by either to the person of the other) contrary to the rule in civil cases, which now admits the testimony of husband and wife for or against each other. The prosecutor, also, notwithstanding his connection with the proceedings against the prisoner, is a competent witness in support of the charge; for such proceedings are carried on in the name of the crown, and the prosecutor has, according to legal construction, no direct interest in the result. His wife, therefore, may be a witness either for the prosecution or for the prisoner.

In the event of the death or illness of a witness, his deposition may be read. In criminal cases, too, instruments are admitted in evidence, although not duly stamped. (17 & 18 Vict. c. 83, s. 27.)

After the examination of each witness, he may be cross-examined on behalf of the prisoner. When the cross-examination is finished, the counsel by whom the witness was called is entitled to re-examine him for the purpose of explaining any matters touched upon or referred to in the cross-examination, into which confusion may have been introduced by the questions on the prisoner's behalf. The court may also put any question it thinks proper to the witnesses, and for this purpose may recall a witness at any stage of the inquiry.

When the case for the prosecution is closed, the prisoner or his counsel (who has, since the passing of the 6 and 7 Wm. IV. c. 114, the same right to address the jury on the merits of the case in felony as he previously had in treason and misdemeanor) is entitled to address the jury, and in so doing to comment on the entire case for the prosecution; and if he intends to adduce evidence, may open that evidence with any particulars he may think proper. After the prisoner or his counsel has finished his address, the witnesses for the defence are to be sworn, and their evidence gone into. The accused is always allowed to call witnesses to speak to his *general* character, as being inconsistent with the imputed offence, and it is for the jury to estimate the value of such evidence.

When the prisoner's evidence is closed, witnesses may be called on behalf of the prosecution to give specific contradictions to the denials by the prisoner's witnesses on cross-examination, and generally to give any evidence in reply which is strictly applicable to the defence and which could form no part of the original case. Where such evidence is given, the prisoner or his counsel has a right to address the jury on it before the general reply for the prosecution.

When the defence is ended, the counsel for the prosecution, in all cases where witnesses have been called on behalf of the accused, is entitled to reply on the entire case and on all the observations made by the other side during its progress; but in practice, where the evidence given on behalf of the accused is confined to character, it is not usual to reply. After the case on both sides is closed, the court sums up the evidence, and in so doing directs the attention of the jury to the precise issue they have to try, and applies the evidence to that issue. Upon the trial of a person for a non-capital felony committed after a previous conviction for felony, the jury is not to be charged to inquire concerning such previous conviction, until they have inquired concerning such subsequent felony and have found such person guilty of the same; and where such previous conviction is stated in the indictment, the reading of such conviction to the jury is to be deferred until after such finding. Where, however, such person gives evidence of good character, the prosecutor may in answer thereto give evidence of such previous conviction, before such finding, and the jury may inquire concerning such previous conviction at the same time that they inquire concerning the subsequent felony. (6 & 7 Wm. IV. c. 111; 14 & 15 Vict. c. 19.) The summing up being concluded, the jury proceed to consider their verdict. If, on consultation in the jury-box, they are not able to agree within a convenient time, they retire, and a bailiff is sworn to keep them together without meat, drink, fire, or candle till they are agreed. This rule, however, has been relaxed in modern times. In cases of misdemeanor, where the trial lasts more than one day, the court will generally allow the jurors to return to their homes, the jury engaging to allow no one to speak to them on the subject of the trial. But in cases of treason or felony, the course has been to permit them to retire in a body to some tavern, where accommodation is provided for them by the sheriff and his officers, who are sworn to keep them together, and neither to speak to them themselves nor to suffer any other person to speak to them touching any matter relating to the trial.

When the jury have agreed upon their verdict, they signify that they are ready to deliver it; and on returning into court for that purpose, their names must be called over, and all twelve must be within hearing when it is given. The foreman of the jury is the person who is to deliver the verdict; and in cases of treason or felony, it can only be received in open court and in the presence of the prisoner: in cases of misdemeanor it may be otherwise. The verdict may be either "Guilty" or "Not Guilty," or may be a special one; and may be "Guilty" upon one count of an indictment, and "Not Guilty" upon others; or may be "Guilty" as to part of a count, and "Not Guilty" as to the remainder, where an offence is charged which includes a lesser crime of the same degree, and the latter only is proved; as where murder is charged, and the proof is of manslaughter; and persons indicted for the actual commission of felonies or misdemeanors may be convicted of the attempt (14 & 15 Vict. c. 100, s. 9.) A special verdict is the finding of all the facts specially, where the jury doubt whether they constitute the offence in the indictment, and leaves the court to give judgment according to the legal effect of the facts so found.

Where upon the trial evidence is given of insanity at the time of committing the offence charged, and the jury acquit, they are required to find specially whether the accused was insane at the time of the commission of the offence, and whether he was acquitted on that account; and if they find in the affirmative, the court is to order him to be detained till the queen's pleasure be known; and she may give such order for his safe custody during her pleasure as she may think fit. (39 & 40 Geo. III. c. 94, s. 1; 3 & 4 Vict. 3. 54, s. 3.) On a verdict of acquittal, or where he is discharged by proclamation for want of prosecution, the prisoner is to be immediately set at large in open court, without the payment of any fines in respect of such discharge. (14 Geo. III. c. 20; 55 Geo. III. c. 50; 8 and 9 Vict. c. 114.)

When a verdict of guilty has been returned against a prisoner, the court, except in the case of prosecutions pending in the Queen's Bench, may proceed at once to pass sentence upon him, unless he allege some matter or thing sufficient in law to arrest or bar judgment. In prosecutions pending in the Queen's Bench, however, the prisoner is allowed four days for moving in arrest of judgment; or, in cases of misdemeanor, for a new trial or writ of *venire facias de novo*. Also where the trial at any sittings or assizes is upon a record of the Queen's Bench, the judge before whom the verdict is taken may, under 11 Geo. IV. & 1 Wm. IV. c. 70, s. 9 (except where the prosecution is by information filed by leave of the Queen's Bench, or such cases of information filed by the attorney-general wherein he prays that judgment may be postponed), pass sentence at once; but such sentence is not to have the force and effect of a judgment of that court, until after the expiration of six days after the commencement of the ensuing term, during which period the prisoner may move for a new trial, or to have the judgment amended. Except in the last-mentioned case of a trial at the sittings or assizes upon a record of the Queen's Bench, or where the offence of which the prisoner is convicted is a misdemeanor punishable by a simple fine, or where the Queen's Bench, after conviction for misdemeanor, thinks proper to dispense with his attendance, sentence cannot be pronounced against a prisoner unless he be present in court at the time.

Judgment may be arrested where the offender has received a pardon since his arraignment or after conviction becomes insane, or, having been out of custody since his conviction, denies that he is the person convicted (in which last case a jury is to be impanneled to try the fact), or for some defect apparent in any part of the record, as regards either the jurisdiction of the court, the statement of the offence or any of the proceedings thereon, but not for any of the mere technical defects specified in 7 Geo. IV. c. 64, ss. 20 and 21. If the judgment be arrested, all the proceedings against him are to be set aside, and judgment of acquittal is to be pronounced in his favour; but he may be prosecuted again for the offence of which he is so acquitted.

A new trial may be had on the application of the defendant in all cases of misdemeanor pending in the Queen's Bench, where it appears to the court that the awarding one is essential to justice; as, for instance, where the verdict is contrary to evidence or the directions of the judge, or evidence has been improperly received or rejected at the trial. The court of Queen's Bench will also in its discretion, where a party is acquitted of a misdemeanor on a prosecution pending in that court, allow a new trial, on the application of the prosecutor, if such acquittal has been obtained by any fraudulent means or practice, as where the party acquitted has kept back any of the prosecutor's witnesses, or neglected to give due notice of trial.

A writ of *venire facias de novo*, the effect of which is the same as granting a new trial, may be awarded where, by reason of misconduct on the part of the jury, or of some uncertainty or ambiguity or other imperfection in their verdict, or of any other irregularity or defect in the proceedings or trial, appearing on the record, the proper effect of the first *venire* has been frustrated, or the verdict has become void in law.

Neither new trials nor writs of *venire facias de novo* are grantable in cases of treason or felony.

Where a new trial or writ of *venire facias de novo* is awarded, the parties stand in the state in which they were immediately before the first trial: the whole case is to be re-heard, and the first verdict cannot be used upon the new trial, or as evidence of any matter found by such verdict, or in argument.

After sentence pronounced against an offender, the judgment of the court may be falsified or reversed, either by plea without writ of error or by writ of error: by the former, for some matter not apparent upon the face of the record, as want of authority in the court by whom the judgment was pronounced; by the latter, for the same matters as are sufficient to arrest a judgment, and also for any material defect in the judgment itself. Where the judgment has been pronounced by a court of oyer and terminer, jail delivery, or quarter-sessions of the peace or of a county palatine, the writ of error is to be brought in the court of Queen's Bench, and for that purpose the indictment and other proceedings thereon must be removed into that court by writ of *certiorari* [CERTIORARI]: where it has been pronounced in the Queen's Bench, it is to be brought in the Exchequer Chamber, before the justices of the Common Pleas and barons of the Exchequer, from whose judgment a writ of error lies to the House of Lords. In cases of treason and felony it is in the discretion of the crown to grant or refuse a writ of error: in all other cases the fiat of the attorney-general must be first obtained, and this he ought to grant upon probable cause of error shown. When issued, the writ of error stays the execution of the judgment, where it has not been carried into effect during the time that such writ is pending, except that in cases of treason or felony the offender is not entitled to be liberated on bail. In cases of misdemeanor, however, where he is imprisoned under execution, or any fine has been levied, either in whole or in part in pursuance of the judgment, he is entitled to be discharged from imprisonment and to receive back any money levied on account of such fine, until the final determination of the Writ of Error. (8 & 9 Vict., c. 68, s. 1.) If the judgment be falsified or reversed, such judgment and the execution thereupon, and all former proceedings, become thereby absolutely null and void; and the person the judgment against whom is so falsified or reversed, if living, and, if dead, his heir or executor, is restored to all things which such person may have lost by such judgment and other proceedings, and stands in every respect as if such person had never been charged with the offence in respect of which such judgment was pronounced against him. If, however, the execution only be erroneous, that only will be reversed; and if the judgment be reversed for some technical error merely, in the indictment or subsequent process, the party may be prosecuted again. If the judgment be confirmed, the prisoner is to be remanded to undergo the remainder of his sentence.

Where there is nothing to arrest or bar a judgment, the execution of it may be prevented by a pardon received after sentence pronounced; but, without express words of restitution, no property which the offender forfeited on his conviction or attainder, is thereby revested in him; nor, unless where the pardon is by act of parliament, is the corruption of his blood removed, except as regards those of his blood born after the granting of such pardon, nor are any of the consequences of such previous corruption prevented.

In capital cases the execution of a judgment may also be suspended by a reprieve, either at the discretion of the Crown, or, where substantial justice requires it, of the court. There are two instances, however, in which the court is bound to grant a reprieve, viz.: 1, where the offender, if a female, is pregnant; 2, where the offender becomes insane after judgment. If the offender allege that she is pregnant or the court have reason to suppose that she is so, a jury of twelve matrons is to be impanneled with all possible despatch to try whether or not she be quick with child. In case they find in the affirmative, the court respites the offender from time to time until she be delivered of a child or it is no longer possible in the course of nature that she should be so. After her delivery or where such delivery is no longer possible as before mentioned, or if the jury find that she is not quick with child, the court at the expiration of the period for which it has respited her, proceeds to award execution against her.

Where insanity is alleged, the court will reprieve the prisoner, if found to be insane by means of an *ex officio* inquiry, or if his insanity otherwise sufficiently appear.

Although there is no right of appeal in criminal cases, a court has been recently formed for the consideration of crown cases reserved. A practice had long existed for the judges on circuit to receive any objections taken on behalf of the accused, which appeared to them worthy of mature consideration, for the opinion of all the judges; and if they, or a majority of them, came to the conclusion that the objection was well founded, the defendant was recommended to the crown for a pardon. Although the decision of the judges in such cases was known, the reasoning by which they arrived at the conclusion did not transpire: while the power of reserving questions of law was not possessed by the courts often most in need of the assistance of the judges on such points, namely, the courts of quarter sessions. Now, however, by the statute 11 & 12 Vict. c. 78, reciting that "it is expedient to provide a better mode of deciding any difficult question of law arising in criminal trials," it is enacted that when any person has been convicted of any treason, felony, or misdemeanor before any court of oyer and terminer, or gaol delivery, or court of quarter sessions, the judge, or commissioners, or justices of the peace before whom the case has been tried, may in his or their discretion, reserve any question of law which has arisen on the trial for the consideration of the justices of either bench and barons of the exchequer; and may respite execution, or postpone the giving of judgment until such question has been decided, and in the meantime either commit the person convicted to prison or admit him to bail.

For the purpose of considering such questions (which are transmitted to them in the form of a special case) the judges meet, five at the least being required, including one chief justice or the chief baron, to constitute a court for the consideration of crown cases reserved, as it is termed, on one or more days in each term; and then in open court deliver their judgment either upon or without argument, reversing, affirming, or amending the judgment already given, or where the conviction is affirmed and no judgment has been already given, ordering when and where it shall be given.

The court which determines these reserved questions of criminal law, is not a court of criminal jurisdiction or appeal in the legal or ordinary sense of the term. It merely assists and guides with its opinion the determination of the court or judge below, in whose discretion is exclusively vested the reservation of the case, and to whom, or to his successor, the judgment (if the conviction be affirmed) is wholly left.

Should the execution of a judgment be neither prevented nor suspended, or, having been suspended, should have ceased to be so, such judgment is to be executed according to law by the sheriff or other authorised person or his deputy. In capital cases, if the offender, after hanging, be taken down before he be dead, he is to be hanged again until he be dead.

As regards the manner in which the various judgments which may be pronounced against offenders are to be executed, the subject is too extensive to be further treated of in an article like the present.

As to the restitution of stolen property, see RESTITUTION. With respect to the expenses of prosecutions for indictable offences, the general provisions on the subject are contained in 7 Geo. IV. c. 64. According to these the court before which any person is prosecuted for felony or the following misdemeanors, namely, assaults with intent to commit felony; attempts to commit felony; riots; receiving stolen property; assaults upon peace-officers in the execution of their duty, or upon persons acting in their aid; neglect or breach of duty by peace-officers; assaults in pursuance of conspiracies to raise the rate of wages; obtaining property by false pretences; indecent exposure of the person; perjury and subornation of perjury, may, at the request of the prosecutor or any other person appearing on recognisance or subpœna to prosecute or give evidence, order payment of the costs and expenses incurred by the prosecutor in preferring the indictment, and also the reasonable expenses of the prosecutor and witnesses for the prosecution in attending before the grand jury and otherwise carrying on the prosecution; and also, whether a bill of indictment be preferred or not, may order the reasonable expenses incurred by any person by reason of attending on any such recognisance or subpœna (such attendance, where no indictment is preferred, appearing to be in *bonâ fide* obedience to the recognisance or subpœna), and, except in cases of misdemeanor, by reason of attending before the examining magistrate, and also, except in respect of attendance before such magistrate in cases of misdemeanor, compensation for trouble and loss of time.

It is difficult to discover upon what principle the selection of the cases of misdemeanor in respect of which the court is empowered to award costs under the above statute was made. Subsequent statutes have however extended the power to indictments for concealment of birth, fraudulently procuring the defilement of women or girls under twenty-one, assaults upon workhouse officers, or relieving officers, neglecting to provide for, or assaulting apprentices or servants; offences under the statute 14 & 15 Vict. c. 19, comprising serious assaults on the person, being found by night armed with intent to commit burglary, &c.; carnally knowing and abusing girls; abduction of unmarried girls under sixteen; conspiring to charge any person with felony, and conspiracy to commit felony; and assaults prosecuted by direction of justices. Other cases might with justice be included; and it may be a question whether, under certain limitations, the power ought not even to be extended to the expenses of the prisoner's witnesses. The costs are taxed by the officer of the court, and paid by the treasurer of the county, who is repaid by the Treasury out of the consolidated fund. (15 & 16 Vict. c. 82.)

Offences punishable on Summary Conviction.

It would be inconsistent with the limits of the present article to give a detailed account of the various offences punishable on summary conviction, in number far exceeding those which are indictable. They relate, however, principally to ale and beer houses, apprentices, petty assaults, the Customs and Excise, distresses, drunkenness, friendly societies, game, hawkers and pedlars, highways, turnpike roads, petty thefts not amounting to larceny, malicious injuries to property, pawnbrokers, railways, stage and hackney carriages, servants, vagrants, weights and measures, and the numerous offences punishable under the Metropolitan Police Acts.

Summary proceedings, except in the case of contempts of the superior courts of justice (which those Courts have been immemorially used to punish by attachment), were wholly unknown to the common law. Their institution appears to have originated partly in the necessity for relieving the ordinary tribunals from the immense increase of labour which would otherwise have been cast upon them, owing to the multiplicity of new offences of a trivial kind which were yearly created for the protection of society as it advanced in population and civilisation, and partly in the desire to do more speedy justice in the case of such trifling offences than would have been possible had they been made indictable. In the case of indictable offences a party cannot in general, as before observed, be put upon his trial until a true bill has been found against him by a grand jury, and cannot be convicted except by the verdict of a petit jury: to have made all these minute offences indictable would therefore have entailed upon the class of persons qualified to serve as jurors a frequency of attendance which would have been found to be most troublesome and harassing. Accordingly numerous acts of parliament have from time to time vested in one or more justices of the peace or other persons the power to try parties accused of trifling offences without the intervention of a jury. The extension, however, of this mode of proceeding has been always regarded with extreme jealousy.

The course of proceeding before justices, as far as regards summary convictions, was until recently regulated by a great variety of statutes, extending from the 18 Eliz. c. 5, to the 6 & 7 Wm. IV. c. 14. These acts have been consolidated, and the duties of the justices clearly defined by the statute 11 & 12 Vict. c. 43, which provides a procedure applicable to the great majority of cases in which a summary conviction or order may be made by justices of the peace out of sessions.

Where an information is laid before a justice or justices of the peace, that any person has committed, or is suspected to have committed any offence or act for which he is liable by law, upon a summary conviction for the same, to be imprisoned or fined, or otherwise punished, and who, when a complaint is made to any justice or justices, upon which he or they have authority by law to make any order for the payment of money or otherwise, such justice or justices are to issue a summons in a prescribed form directed to the party charged, stating shortly the matter of such information or complaint, and requiring him to appear and answer the same, and be further dealt with according to law.

This summons must be served by a constable, peace officer, or other person to whom it is delivered, on the person to whom it is directed, either personally, or by leaving the same at his last or usual place of abode.

If the person so summoned does not appear after having been served a reasonable time, the justices, upon proof to their satisfaction, substantiating the matter of the information or complaint, may issue a warrant to apprehend the accused, or may proceed ex-parte.

In the case of an information being laid, and satisfactorily substantiated by oath or affirmation, a warrant may be issued in the first instance; but the usual course is, in the first instance, to proceed by summons. The warrant in either case must be under the hand and seal of the justice or justices, and be directed to the constable. It must state shortly the matter of the information or complaint on which it is founded, and it remains in force until executed.

Summonses (followed by warrants if necessary), may be issued to compel the attendance of witnesses for either party.

The information or complaint is to be heard and determined by such number of justices as the particular act of parliament on which it is founded may provide, or when there is no such direction, before any one justice.

The room or place in which the proceeding takes place is to be deemed an open court, to which the public are to have free access; and the defendant may make his full answer and defence, and have the witnesses examined and cross-examined by his counsel or attorney.

When the justices have heard what each party has to say, and the witnesses, they consider the whole matter and proceed to convict, or make an order on the defendant, or to dismiss the information or complaint; every conviction or order being drawn up in a prescribed form, and lodged with the clerk of the peace, and a certificate of every order of dismissal being also given to the defendant.

It is competent to the court to award costs, either against the defendant or against the complainant, as the case may be; and for the amount of such costs, or of any pecuniary penalty, to issue a distress warrant. When there is no distress to be found, or when the statute simply directs imprisonment, a warrant of commitment issues. If the parties are satisfied that a warrant of distress would be ruinous to the defendant, or that he has no goods, the court is authorised to issue a warrant of commitment in the first instance.

It must be observed that the statute 11 & 12 Vict. c. 43, does not extend to informations, complaints, or proceedings relating to the excise or customs, stamps, taxes, or post-office, nor to the removal of paupers, nor to complaints or orders with respect to lunatics or bastards, nor to proceedings relating to the labour of children in mills or factories.

For the method of proceeding with respect to such offences, reference must be made to the statutes on the subject.

The principal authorities besides the statutes of the realm which have been consulted in the preparation of this article, are Hawkins's 'Pleas of the Crown;' Blackstone's 'Commentaries,' by Kerr; Russell, 'On Crimes and Misdemeanors;' Chitty's 'Criminal Law;' Starkie's Treatises 'On the Law of Evidence and On Criminal Pleading;' Dickenson's 'Guide to the Quarter-Sessions,' by Talfourd; the various Reports of the Criminal Law Commissioners; and Paley 'On Convictions,' by Macnamara.

LAW MERCHANT. [LEX MERCATORIUS.]

LAWN, a space of ground covered with grass, kept short by mowing and generally situated in front of a house or mansion, or within the view from such. The number of evergreen exotics which survive our winters, and the verdure of the grass in summer, are peculiar features of England in comparison with continental Europe, where in general the grass is either burned up in summer, or the exotics are destroyed by the severity of winter. The management of a lawn is with us therefore a subject of interest to every possessor of a garden.

Previous to laying down, the ground intended for a lawn should be properly trenched and drained, in order that such trees and shrubs as may afterwards be planted upon it should succeed well. The direction of the trenches should be towards a drain, to which, if possible, their bottoms should form a regularly inclined plane, for the purpose of affording the means of escape for the water, which, in retentive soils more especially, would otherwise stagnate. Although trees and shrubs are absolutely necessary for giving due effect to the scenery of a lawn, yet in the latter, one open extensive space, lying in the full view from the windows of the house, must be preserved. For this portion, digging instead of trenching may be found sufficient; but the openings, which ought to command views from this principal area, should be trenched, as well as for the shrubs and trees; for if the operation were only performed with regard to the latter, the water would not find such free egress from the bottom as would be the case if the mode of trenching were adopted as is above recommended.

After trenching, the soil should be allowed to subside, and the greatest care should be taken to make the surface perfectly even, otherwise a great expense will be afterwards incurred by the loss of time in mowing, which can neither be so quickly nor so well performed where the surface is uneven.

If turf can be readily procured, a lawn is at once produced; and by such means a more uniform distribution of grass may be obtained than by any other means. The surface of a well-fed meadow, or of an old common, closely cropped by sheep and geese, affords the best kind of turf; and if any tall or coarse grasses should be mixed with it, no inconvenience will arise, for everything of this sort will eventually disappear under close mowing; and such only as are dwarf and suited to the soil will ultimately remain. Where a turf is to be produced by sowing, the seeds of such species as are indigenous to the locality, and possess at the same time the property of being dwarf and fine, are to be preferred; but in the event of this method of forming a lawn being adopted, it is always desirable that a narrow slip of good turf should be carried all round the circumference. The following species may be mentioned as proper for a lawn in average situations:—*Lolium perenne*, or rye-grass; *Poa trivialis*, or *pratensis; Anthoxanthum odoratum*, or sweet vernal; *Cynosurus cristatus*, or crested dogstail, with a considerable quantity of *Medicago lupulina*, or black nonsuch, and *Trifolium repens*, or Dutch white clover. If the situation is particularly dry, *Festuca ovina*, or sheep's fescue, should be substituted for *Lolium perenne;* if very low and wet, then the place of the latter may be filled with *Alopecurus pratensis*, or meadow foxtail. All these grasses may be procured of dealers in agricultural seeds; it is however better for persons in the country to collect for themselves such as can be found in their neighbourhood, for then they can depend upon their being genuine. The utmost care should be taken to avoid the introduction of *Dactylis glomerata*, or cocksfoot grass, and *Holcus lanatus*, or *mollis*, for these hard, harsh, stubborn grasses resist the effects of mowing for a long time, The great plague of lawns is the dandelion (*Leontodon taraxacum*), which should be carefully rooted out as soon as seen, though there is no guarding against seeds.

The process called inoculating, or of making lawn by sowing the ground with fragments of turf, and rolling them in, cannot be recommended when a lawn is required to look particularly well, for it is a long while before the surface of the ground becomes uniform under such circumstances.

Lawns, when once established, require only to be kept neat by the ordinary routine of rolling, mowing, and sweeping, except keeping the surface perfectly even, by making up small hollows, with screened mould, early in spring. When lawns become worn out, a top-dressing of any finely-divided manure will refresh them: malt-dust applied in October is excellent for this purpose; and at the same time an additional quantity of grass-seed may be sown. Where the walks are straight, the edges of the lawn adjoining them should be perfectly straight also, and care should be taken that the grass-edging is kept rolled down and pared, so as never to exceed an inch and a half above the level of the walk.

The lawn, however, in the case of mansions of any architectural pretensions, should not be brought up close to the building; but there should be intervening terraces with flower beds. Where the mansion is dropped, as it were, upon the lawn, it takes an air of incompleteness as well as coldness. The domains of art and nature should be harmoniously united, and not brought into abrupt contrast. This plan is now almost uniformly adopted alike by eminent architects and decorative gardeners.

(Lindley, *Theory and Practice of Horticulture;* McIntosh, *The Book of the Garden.*)

LAY-BROTHERS, pious but usually illiterate persons, who devoted themselves in some convent to the service of the religious. They were usually employed as agriculturists at the grange or farm, or as artisans in the house; and were not admitted under 24 years of age, or above 43. A lower class of these were *Oblati*, who devoted themselves to more menial servitude. There were also *Fratres ad succurrendum*, assistant brothers, who wore only a short scapulary, while the professed lay-brother had the habit of the order, but wore their beards while the monks shaved. The institution of lay-brothers of the professed kind began in the 11th century. The Jesuits termed their lay-brethren *coadjutores*. There were *lay-sisters* also in the nunneries, whose duties consisted in washing, cooking, weaving, attending on the professed nuns, and other menial offices. They were not admitted under 20 years of age. (Fosbrooke's *British Monachism.*)

LAYERING is an operation by which the propagation of plants is effected by laying down or bending the shoots, so that a portion of them can be covered with earth. A shoot so operated on is called a *layer*, and the point which furnishes the layers bears the name of *stool*. Some plants are so much disposed to emit roots that if their branches happen to come in contact with the earth they immediately begin to strike. But although it may be easily imagined that the observation of this common circumstance has led to the artificial practice, yet some additional operations besides that of merely bringing a shoot in contact with the earth are found necessary for many plants on which this mode of propagation is practised. The principle by which the operation is rendered effectual for the object in view is the following:—When the shoot of a species not freely disposed to send forth roots has merely its bent part inserted in the earth, the woody matter organised by the leaves passes down to the roots nearly as usual; but if the communication along the alburnum is interrupted by an acute bend, twist, or incision, a *callus* will be formed, from which by degrees spongioles are emitted, and thus roots ultimately produced. A common error is to bury the layer too deep in the earth; for trees and shrubs, the depth should be from three to six inches, and the shoots of the previous season are the best fitted for the operation, the incision being made immediately under a bud or joint.

The part of the shoot intended to form a layer should be divested of leaves where it is to be covered with the mould, and a slit should be made on the bent part, or the branch should be twisted half round at the bend so as to disarrange the woody tissue, or the bark should be half or three-quarters *ringed:* the top of the shoot being bent gently upwards in order to give the plant an upright tendency in its after growth, while at the same time that position keeps the incision from closing; the branch is then fixed down by pegs or hooked sticks, cut down to within an inch or so of the ground, and covered with good mould, which should have been previously well stirred, and afterwards be kept tolerably moist. In general roots are emitted in a few weeks, and by the end of a season young plants are obtained quite fit for transplantation. Some plants however require to be left for two years *on the stools* before they are removed, and there are some which can hardly be made to root at all in this manner.

Plants so situated as to render it impossible to bend their branches to the ground may nevertheless be layered by having their shoots introduced into a pot or box of soil elevated to them, and supported in a convenient position. This is a common practice among the Chinese, who cause branches of trees to root in this manner by partially ringing them, and covering the parts so ringed with a ball of clay, which is kept moist.

LAZARETTO is the name given to certain buildings and enclosures which are annexed to seaport towns, chiefly in the Mediterranean, for the sake of keeping therein confined the crews of ships and passengers arriving from Turkey, or other places where the plague, or other disease deemed contagious, is known to prevail. The persons thus confined are said to be in quarantine, from the Italian word *quaranta*, "forty," because the period of confinement for those arriving from actually infected places is forty days, after which, if no one has fallen ill, they are set at liberty. A lazaretto generally consists of various detached buildings with courts between, the whole surrounded by a wall, and placed in airy situations outside of the town, and on the sea-shore, and in some instances on a small island or rock near the coast. Besides the lodging-houses for persons in quarantine, there are large warehouses in which goods capable, or supposed to be capable, of communicating the disease, such as wool, cotton, leather, &c. are purified. This purification is effected by spreading them out in the air for a length of time, and stirring and turning them about, which is done by the "guardiani," or keepers of the establishment, who, it is supposed, if there were any infection, would speedily take it. These "guardiani" are kept in strict quarantine, but are well paid for the confinement and risk. These establishments are kept under very strict regulations, any infringement of which is visited by severe penalties, amounting in some cases to death. The principal lazarettos were those of Venice, Leghorn, Marseille, Trieste, Genoa, Messina, and Malta. That at Marseille occupied fifty acres, but has been lately taken in to enlarge the town. The name "lazaretto" is derived from St. Lazarus, who, in the Roman calendar, is the patron of lepers, and as leprosy was a very common disease in Italy and other parts of Europe during the middle ages, the hospitals in which lepers were confined obtained the name of lazaretto, and the lepers themselves were called lazzari, a word which has perpetuated itself in the lazzaroni, or lowest class of the inhabitants of Naples, because, as some believe, of their dress, which resembles that which was worn at one time by the lepers. Houses for lepers in England were often called lazar-houses. John Howard wrote 'An Account of the principal Lazarettos in Europe,' 4to., 1789, republished in London, 4to., 1791. From this work it appears, that the lazaretto of Venice was the earliest, and that the rules and tariffs of the other lazarettos in Europe were copied from it. The health-office in that city, by which the lazaretto is conducted, was instituted by a decree of the senate in 1484, during a time of pestilence.

In most commercial ports at present, the practice is, in case the incoming ship has not a clean bill of health, to place the ship itself in quarantine, that is, to prevent any intercourse with the shore, or with any other vessel, till it is clearly ascertained that there is no infectious disease on board. In England and some other countries, the doubts that have been thrown on the theory of contagion have relaxed the strict observance of these precautions; and lazarettos are falling out of use. [Quarantine.]

LEAD (Pb, from the Latin *plumbum*). This well-known metal has been in use from the very earliest times; it is frequently mentioned in the books of Moses, and Pliny describes the manufacture of leaden pipes. The alchemists called it *Saturn* (♄), first, because they thought it the oldest of the seven then known metals, and it might therefore be compared to Saturn, who was supposed to be the father of the gods; and second, from its power of dissolving other metals it was further likened to Saturn, who, according to fabulous history, was in the habit of devouring his own children.

With a few very rare exceptions, lead is never found native or in the metallic state. Its ores are numerous [Lead, in Nat. Hist. Div.], but it is chiefly from that known as *galena*, or sulphide of lead, that the metal is obtained. This ore contains from 75 to 83 per cent. of lead, according to its purity.

Lead crystallises in regular octohedra, and sometimes in four-sided pyramids, but as usually obtained—by allowing a quantity of melted lead slowly to cool till the external part has solidified, then boring a hole through the crust and pouring out the still fluid metal from the interior, on the sides of which the crystals will be found—they present a fern-like appearance, somewhat similar to the form in which chloride of ammonium crystallises. By repeated melting in a vessel to which air has access, lead becomes more and more brittle, owing to its dissolving a portion of the oxide that forms on its surface; this may be prevented by covering it with a layer of charcoal; if already slightly oxidised it may be re-softened by well agitating it with charcoal. Lead boils at a white heat, and even at a red heat begins to volatilise. Cold hydrochloric or sulphuric acids have no action upon it, and at a boiling temperature dissolve only a small portion. Nitric acid, especially when rather dilute, converts it into nitrate of lead with evolution of binoxide of nitrogen. Acetic acid in the presence of air rapidly attacks it. [Lead Manufacture *white lead.*] Sulphate of lime and moisture also quickly corrode lead, hence in making cisterns and roofing houses, contact of the metal with plaster of Paris, &c., should be avoided. The alkalies appear to have little or no action upon lead.

Lead is soft, easily taking impressions, of a bluish-white colour, and not possessed of much ductility or tenacity. It melts at 620° Fahr., and at the moment of solidification contracts considerably, so that it is not well adapted for taking castings.

The equivalent of lead is 103·57, and its specific gravity 11·44.

A freshly cut surface of lead has a high metallic lustre, and this is retained if the metal be preserved in a hermetically sealed tube filled with perfectly dried air, or in a similar tube filled with water freed from all traces of air by long boiling. If the air, however, contain vapour of water, as is always the case under ordinary circumstances, then the bright surface rapidly tarnishes owing to the formation of a film of oxide. Pure water also in contact with air very rapidly and extensively acts upon lead, oxide is formed, carbonic acid is absorbed, and in a short time the metal becomes transformed into a white, flaky powder, composed of hydrated oxide and carbonate of lead ($PbO, HO + PbO, CO_2$). A very moist atmosphere produces the same result, though, of course, much more slowly; moreover, the hydrated basic carbonate produced is ultimately converted into anhydrous protocarbonate, owing to the replacement of the water of hydration by the carbonic acid of the atmosphere. An old leaden coffin, examined by Tuson ('Phil. Mag.,' April, 1860), was found to have been nearly all changed into this condition, 93 per cent. of it being pure anhydrous carbonate of lead (PbO, CO_2).

Compounds of Lead.

Lead and *oxygen* form four oxides, namely:—

1. Dinoxide of lead	Pb_2O
2. Protoxide of lead	PbO
3. Red lead	$x\,PbO, PbO_2$
4. Binoxide of lead	PbO_2

1. *Dinoxide of lead* (Pb_2O), *suboxide of lead*, is a black powder obtained by cautiously heating oxalate of lead in a retort from which air is excluded. It is an unimportant oxide.

2. *Protoxide of lead* (PbO). *Litharge. Massicot.* The fused oxide that is produced in the process of cupellation, already described in treating of the purification of lead, is the protoxide. On cooling, it solidifies into a mass of reddish-yellow scales, and is known in the arts under the name of *litharge.* When ground it is used as a pigment by painters and decorators, also in the manufacture of acetate of lead, and sometimes enters into the composition of glazes used at glass-works and potteries. *Massicot* is protoxide of lead that has not undergone fusion. It is produced in making red lead.

The *hydrated oxide* ($x\,PbO,HO$) falls as a white precipitate on adding an alkali to an aqueous solution of a lead salt. It is soluble in solutions of the fixed alkalis, compounds being thereby formed that sometimes are called *plumbites.* When heated it loses water, and yellow anhydrous protoxide remains.

Protoxide of lead is a powerful base, forming with acids *salts of the protoxide.* It has a great tendency to form basic salts.

3. *Red-lead* (*Minium*). This compound usually contains $Pb_3O_4 = 2PbO + PbO_2$, but sometimes has the composition Pb_2O_3, and occasionally Pb_4O_5; in fact it may be looked upon as a compound of binoxide of lead with one, two, or three equivalents of protoxide. All three varieties are of a brilliant red colour. Red lead is largely used as a pigment by the painter and the paper-stainer, and by the glass-manufacturer. [Glass.] For the preparation of red lead, see Lead Manufacture.

4. *Binoxide of lead* (PbO_2) is usually prepared by digesting red-lead in boiling nitric acid, whereby the protoxide is dissolved out, and the binoxide remains as a *puce-coloured* powder. When fused with alkalies it forms crystallisable salts, called *plumbates.* The potash salt contains $KO,PbO_2,3Aq$.

Lead and *Phosphorus* form a somewhat indefinite *phosphide.* It is unimportant.

Lead and *Sulphur* form *disulphide of lead*, Pb_2S, and *protosulphide* (PbS), obtained as a black precipitate on passing sulphuretted hydrogen through a solution of a salt of lead. The protosulphide occurs native under the name of *galena;* it has already been described at the commencement of this article, and also in Nat. Hist. Div., under Lead.

Lead and *Iodine* form one combination, the *protoiodide of lead* (PbI). It falls as a bright yellow powder on mixing solutions of iodide of potassium and acetate of lead. It is slightly soluble in cold water, but much more so in hot water, from which solution it separates out on cooling in brilliant yellow silky scales.

Several *oxyiodides* of lead also exist.

Lead and *Bromine* form *protobromide of lead* (PbBr), a white precipitate resulting from the mixture of solutions of an alkaline bromide and a lead salt. From solution in hot water it separates out in white shining needles.

Lead and *Chlorine* form

Protochloride of lead (PbCl), *chloride of lead.* It is best prepared by precipitating nitrate of lead with chloride of sodium; it always, however, falls as a white powder when hydrochloric acid or a soluble chloride is added to an aqueous solution of a lead salt. Chloride of lead is soluble in boiling water to the extent of 3 per cent., depositing again on cooling in beautiful white silky needles. On the application of heat to it in the dry state it readily fuses, and solidifies on cooling to a semi-transparent mass termed *horn-lead.*

The *oxychlorides of lead* are numerous. One occurs native (PbCl,2PbO) [Lead, *Berzelite*, in Nat. Hist. Div.] at the Mendip Hills, in Somersetshire, and is hence frequently called *Mendipite.* Another, the subject of a patent, and used as a substitute for white lead, is made by acting upon galena with hydrochloric acid, dissolving the chloride of lead thus produced in hot water, and precipitating with sufficient lime water to remove one half only of the chlorine. The re-action is as follows:—

$$\underbrace{2\text{PbCl}}_{\text{Chloride of lead.}} + \underbrace{\text{CaO}}_{\text{Lime.}} = \underbrace{\text{CaCl}}_{\text{Chloride of calcium.}} + \underbrace{\text{PbO, PbCl}}_{\substack{\text{Pattinson's}\\ \text{oxychloride.}}}$$

Cassel or *Turner's yellow* is an oxychloride of lead, much used as a pigment. It is prepared by heating chloride of ammonium with ten times its weight of litharge.

Fluorine and *Lead* form a white sparingly soluble *fluoride of lead* (PbFl).

Salts of Protoxide of Lead.

Carbonate of Lead (PbO,CO_2). This compound is precipitated as a white powder whenever solutions of an alkaline carbonate and a lead salt are mixed together. It is insoluble in water, but easily soluble in nitric or hydrochloric acids.

White-lead, as it occurs in commerce, is generally basic carbonate of lead, containing about 7 per cent. of linseed oil. It is also met with unmixed with oil, and is then in the form of a heavy, white, amorphous powder, technically termed *dry white-lead.* White-lead may, however, as already indicated, be an oxychloride of lead, or even a neutral carbonate, and is often adulterated with sulphate of baryta, sulphate of lime, and carbonate of lime.

The old *Dutch method* of manufacturing white-lead consisted in suspending thin sheets of lead in long wooden boxes, at the bottom of which was weak acetic acid. See Lead Manufacture. The boxes were placed in a close stove-room, were either surrounded with horse-dung or had wine-lees put into them, and were subjected to a temperature of 85° to 90° for about a fortnight.

The changes which take place in this process may be shortly stated as follows. The spent tan, or horse-dung, or wine-lees, slowly decompose, generating heat, and evolving carbonic acid. The heat volatilises the acetic acid, and this, with the oxygen of the atmosphere, forms with the metal a basic acetate of the oxide of lead. The carbonic acid derived from the eremacausis of the organic matter decomposes this basic acetate, forming carbonate of lead and neutral acetate; the latter soon becomes basic again, and the same decomposition goes on over and over again, till the metal is entirely converted into basic carbonate.

Phosphates of lead.—The alkaline triphospates, biphosphates, and monophosphates, give white precipitates with aqueous solution of acetate or other lead salt. They are all soluble in nitric acid, and have a composition corresponding to the alkaline phosphate that precipitated them. A *chlorophosphate of lead* ($3(3PbO,PO_5)+PbCl$) is found native. [Lead, *pyromorphite*, in Nat. Hist. Div.]

Sulphate of lead (PbO,SO_3) also occurs native. [Lead, *anglesite*, in Nat. Hist. Div.] It is formed as a white precipitate on adding sulphuric acid or a sulphate to a lead salt. It is a heavy powder, soluble to a greater or less extent in ammoniacal salts and in hyposulphite of soda. It is also slightly soluble in strong nitric or sulphuric acids: commercial sulphuric acid generally contains sulphate of lead as an impurity from the chambers in which it is prepared; dilution with water precipitates it.

Nitrates of lead are four:—

Sexbasic nitrate of lead . . .	$6PbO, NO_5+Aq$
Trinitrate	$2(3PbO, NO_5)+3Aq$
Dinitrate	$2PbO, NO_5+Aq$
Mononitrate	PbO, NO_5

The last, or ordinary *nitrate of lead* is the only one of importance. It is readily made by dissolving oxide of lead in diluted nitric acid. On evaporating the solution it crystallises out in more or less opaque octohedra. It is soluble in eight times its weight of cold water; paper or tinder saturated with the solution and dried is thereby rendered exceedingly inflammable.

Hyponitrates ($xPbO,NO_4$) and *nitrites* ($xPbO,NO_3$) *of lead* are formed when metallic lead is boiled with nitrate of lead. The strength of the solution and the extent of ebullition determines which of these is produced. They are all more or less crystalline.

Borates of lead result when boracic acid is fused with oxide of lead. One of them enters into the composition of Faraday's optical glass.

Silicate of lead is abundantly formed in the manufacture of flint glass. [Glass.]

Tungstate of lead occurs native. [Lead, in Nat. Hist. Div.] It forms when ground up with oil a pigment resembling white lead.

Chromates of lead.—The two principal are (1) *neutral chromate*, PbO,CrO_3, and (2) *dichromate* ($2PbO,CrO_3$).

1. *Chromate of lead*, or *chrome yellow*, occurs under many different names. [Colouring Matters.] It is obtained on adding a clear solution of neutral chromate of potash, soda, or lime, to a solution of nitrate or acetate of lead, well washing the precipitate and drying it out of any possible contact of sulphuretted hydrogen.

2. *Dichromate of lead*, or *Orange chrome.*—It is made by boiling white lead in a solution of bichromate of potash, or by fusing yellow chrome with five times its weight of nitre, and well washing the product.

For a description of the details necessary to be attended to for the production of *lead chromes* of various shades, see a paper in the 'Pharmaceutical Journal,' vol. xv., pp. 66 and 69.

Tartrate of lead ($2PbO,C_8H_4O_{10}$).—Precipitate acetate of lead dissolved in water with half its weight of tartaric acid, and wash and dry the precipitate.

When tartrate of lead is heated in a closed tube it is decomposed, white vapours are evolved, and a mixture of metallic lead and carbon remain in an exceedingly minute state of division. On being thrown out into the air the mixture takes fire spontaneously, and is commonly known as the *lead pyrophorous.*

Acetates of lead. [Acetate.]

Alloys of lead. [Britannia Metal; Pewter; Solders; Shot; Type-metal.]

Tests for lead.—This metal is recognised in solution by the yellow precipitate of chromate with chromate of potash; white, soluble in excess with the alkalies; white, insoluble with sulphuric acid or a sulphate. The formation of iodide of lead by adding a few drops of iodide of potassium solution, is perhaps the most characteristic test for lead, as the precipitate dissolves when heated, and is deposited again on cooling in the well-known beautiful golden yellow scales. Sulphuretted hydrogen is, however, the most delicate test for lead. The formation of arborescent crystals of lead, by suspending a piece of zinc in a solution of acetate of lead, is an illustration of how one metal, having more powerful affinities than another, becomes a test for the latter. Thus *zinc* is a *test for lead.*

Estimation of lead.—This is generally effected in the state of sulphate, which contains 68·31 per cent. of metal.

LEAD, MEDICAL PROPERTIES OF. In a purely metallic state, lead produces no action on the human system, except such as arises from its mechanical properties; but as soon as it has become oxidised, it can combine with the contents of the stomach, and produce different effects, according to the nature of the substances it meets with, hence even a leaden bullet, swallowed, has given rise to the symptoms characteristic of the presence of lead. "In whatever form lead is habitually applied to the body, it is apt to bring on the train of peculiar symptoms: the inhalation of its fumes, the habitual contact of any of its compounds with the skin, the prolonged use of them internally as medicines, or externally as ointments and lotions, and the accidental introduction of them for a length of time, with the food, may, sooner or later, equally induce *colica pictonum*, or painters' colic. Of all exposures none is more rapid or certain than breathing the vapours or dust of the preparations of lead." (Christison.) Thus the workmen at Lead Hills in Lanarkshire are stated never to have the lead-colic until they work at the smelting furnaces. The action of lead on the human frame differs greatly according to the kind of preparation of lead, the quantity employed, the length of time or frequency of exposure to it, and the channel of its introduction into the body, and idiosyncrasy of the individual. If injected into a vein, acetate of lead, even in small dose, will produce almost immediate effects; while if taken into the stomach it is much slower, and a considerable quantity is requisite to produce serious consequences. In the latter instance the effects are both local and remote: "One class of symptoms indicates inflammation of the alimentary canal; another, spasm of its muscles; and a third, injury of the nervous system, sometimes apoplexy; more commonly palsy, and that almost always partial and incomplete. Each of these classes of symptoms may exist independently of the other two; but the last two are more commonly combined." (Christison *On Poisons*, p. 511.) The rapidity of action is also determined by the solubility of the preparation or salt of lead; while the degree of effect is also closely connected with the solubility, the more insoluble salts being nearly powerless—a circumstance which supplies a convenient mode of disarming the others of their virulence by converting them from soluble to insoluble salts. Fatal cases from poisoning by large quantities of the salts of lead are not numerous, as there is in general time to administer antidotes; but death from the slow and insidious introduction of lead into the system is of frequent occurrence. The principal source of these is the use of water or other fluids containing lead in solution, the intermixture of lead, as adulterations or accidentally, with articles of food, or handling preparations of lead in the daily business of artisans, such as painters, plumbers, &c.

The danger of using water from leaden pipes or cisterns was known even to the Romans, "among whom, however, the reservoirs were either of marble or cement, or of copper lined with tin, or of other metals more precious" (Alderson); nevertheless, pipes and cisterns of lead are still extensively used, and the rarity of any fatal results shows that the risk has been overrated. This is sufficiently explained by the protecting power of the insoluble salts of lead, formed by the action of the ingredients of the water on the lead, which hinders the subsequent supplies of water from coming in contact with the metal. [LEAD, Col. 144.] No water should ever be drunk or employed for culinary purposes out of *new* cisterns; but water should be allowed to stand in them for some time without being renewed, for only after a crust has been formed does the water become safe; or to expedite this, a little phosphate of soda or iodide of potassium may be added, or a few drops of sulphuric acid may be used. The expedient of Mr. Chatterton of an inside lining of gutta percha to pipes or cisterns removes all danger. The lid or cover of cisterns should never be made of lead, as the vapour which condenses on it possesses all the solvent power of distilled water. It is also unsafe to use water which has flowed over leaden roofs, more particularly in towns, as the surface of the lead is almost invariably coated with some soluble salt; this Dr. Medlock attributes to nitrous acid being present in the atmosphere of towns. It is, however, an error to attribute all the changes which lead used for roofs or cisterns undergoes solely to the corrosive power of water. (See case by Dr. Wall, quoted in Christison, p. 488, edition 1836.) The holes with which the lead is often riddled are caused by the larva of an insect, the *Callidium bajulus*, in the stomach of which lead is often found. (Kirby and Spence's *Entomology*, i., p. 235.) The *Urocerus juvencus*, Linn. and *Anobium striatum*, likewise perforate lead.

Perfumed distilled waters, such as orange-flower water, often contain lead in solution, derived from the solder cementing the copper vessels in which these are imported, whenever lead has been employed instead of tin solder.

No kind of adulteration or impregnation with lead, from accident or ignorance, is more common than that of wine or cyder. Even a single shot of lead left by accident in a bottle after cleaning has produced severe colic; and the more extensive use of the salts of lead to *fine* wines, as it is termed, that is, to remove their acid taste and make them sweet, has occasioned most serious consequences. In the cyder-presses, and in the worms of stills, lead was formerly employed, but it is now nearly banished from use. Lead is sometimes employed either ignorantly or fraudulently, to render tart and bad wines marketable. The lead, if present, may be detected by appropriate tests, among others by *Hahnemann's wine test*, made by putting into a small phial 16 grains of sulphuret of lime, prepared in the dry way, and 20 grains of cream of tartar. The phial is to be filled with water, well corked, and occasionally shaken for the space of ten minutes. When the powder has subsided, the clear liquor is to be decanted off, and preserved in a well stopped bottle. This liquor, when fresh prepared, discovers lead by causing a dark-coloured precipitate. Domestic and British wines, the nature of the fruit used in preparing them unavoidably causing them to be more acid than those prepared from the grape, are most likely to be impregnated with lead, particularly as in some cookery books it is ignorantly recommended to sweeten them.

Another important source of impregnation of articles of food with lead is connected with the use of earthenware glazed with lead. Anything containing vegetable acids, if kept in such vessels, will act on the lead, and may produce poisonous effects. Even milk cannot be kept with safety in leaden-glazed dishes. For all preserves, jellies, &c., Bristol-ware, which is glazed with salt, should be employed. Nothing can be more dangerous than to keep vinegar in leaden bottles, or even in jars glazed with lead. The use of acetate or sugar of lead to clarify syrups or honey, or to render brandy pale, is to be avoided. Rum, hollands, and geneva are occasionally adulterated with lead, and cause extensive evil. Colouring cheese with red lead is equally hazardous.

Nitrate of lead in solution in water—1 part of nitrate of lead to 10 parts of water, termed Ledoyen's disinfectant—is useful put into night-tables, as a destroyer of sulphuretted hydrogen and sulphuret of ammonium. But it is inferior to manganate of potash. [DISINFECTANTS.]

In small medicinal doses acetate of lead, which is almost the only salt administered internally, produces a direct action on the secretions of the stomach, combining with the albumen, and forming compounds which are for the most part insoluble in water and acids, but occasionally forming other compounds which are soluble by the addition of a small quantity of acetic, hydrochloric, or lactic acid. As these acids exist in variable quantities and under different circumstances, the degree and kind of action will be different, according as the lead is dissolved and conveyed to distant organs, or as it remains nearly undissolved and accumulated on the mucous membrane. In the greater number of cases it is very slowly introduced into the circulation. Even a considerable dose may display merely local effects, exciting irritation and inflammation; though these are sometimes followed by colic, convulsions, coma, or local palsy, and amaurosis or deafness.

By a repetition of small doses the secretion of most mucous surfaces is diminished, and constipation occurs; the heart's action is reduced, and the calibre of the arteries is lessened and exhalation checked: if hæmorrhage should exist, that generally stops. Acetate of lead thus appears to be decidedly sedative and astringent. It manifests its sedative effect even when applied externally, and lessens discharges from ulcers, though its application to these is not always safe. Even white-lead (carbonate of lead) ointment applied to ulcers has proved fatal.

Acetate of lead should always be dissolved in distilled, not in common water. It is a most improper application to inflamed cornea whenever that is ulcerated, as it forms a white compound which is apt to get imbedded in the cornea.

The diseases in which it proves most useful are increased discharges, either from mucous surfaces or in hæmorrhages. Vinegar should always be given at the same time. In diarrhœa, dysentery, but, above all, in cholera, when combined with opium, it is a most efficacious remedy (Dr. Graves, in 'Medical Gazette,' Oct. 14, 1837); in fevers attended with diarrhœa it is also useful. Combined with opium on which boiling water has been poured, it forms a most grateful wash to erysipelatous and other inflamed surfaces. In all cases care must be observed in its use. In poisoning by acetate of lead or by litharge, the best antidotes are sulphate of soda (Glauber salts), sulphate of magnesia (Epsom salts), or alum, to decompose or form an insoluble compound, and afterwards the stomach-pump may be used, or emetics of sulphate of zinc may be given. [PAINTERS' COLIC.]

The whole subject of the action of lead upon the human system has been very fully treated by Dr. James Alderson, in his 'Lumleian Lectures,' printed in the 2nd vol. of the 'Lancet,' for 1852, p. 72, &c.

LEAD MANUFACTURE. Lead (French, *plomb*; Italian, *piombo*; Spanish, *plomo*; Portuguese, *chumbo* (all from the Latin *plumbum*); German, *blei*; Dutch, *loot*; Russ., *swinets*) was known and used by the Greeks and Romans for various purposes; among others, it was employed for pipes to convey water, just as it is now. The lead-mines of Britain were worked by the Romans, of which we have evidence in the pigs of lead preserved in the British Museum, and stamped with the names of the emperors Domitian and Hadrian. The early writers in this country, when speaking of the metals, are so confused, that it is by no means certain of which of them they are treating. This confusion is so great, that Sir George Harrison, when writing in exposition of the stannary laws of England, says, "in a liberal construction, copper is tin." The framers and early expounders of those laws fell into some strange mistakes regarding even the nature of particular metals: these mistakes affected lead as well as other metals.

The principal lead-mines in Great Britain are in Cornwall, Devonshire, Somersetshire, Derbyshire, Durham, Lancashire, Cumberland, Westmoreland, Shropshire, Flintshire, Denbighshire, Merionethshire, and Montgomeryshire; in Scotland, at the Lead Hills on the borders of Dumfriesshire and Lanarkshire, in Ayrshire, and in Argyleshire. In Ireland, lead is found in the counties of Armagh, Wexford, Wicklow, Waterford, Clare, and Down. No certain account of the produce has ever been obtained: the proprietors or occupiers of the principal mines declining, from prudential motives, to give detailed statements to that effect. In recent years, however, approximate estimates have been made, which we shall notice in a later paragraph.

The ore of lead, when extracted from the mine, is called *galena*, and is combined with various earthy matters. This galena, an impure sulphide or sulphuret, is the most important among the ores of lead; it contains 86 parts of lead to 14 of sulphur. Of other ores of lead, very few are used as sources of the metal. The mining operations need not be specially described here. [MINING.]

The first processes subsequent to its extraction are those of crushing or pounding and washing the ore, in order to separate as far as possible by mechanical means the impurities from the metal. The ore is then smelted, sometimes in a common smelting-furnace and sometimes in a reverberatory furnace, both of which are very similar in form and construction to the furnaces used for melting and puddling iron. [IRON MANUFACTURE.] When the fusion has been continued long enough to cause the expulsion of the sulphur contained in the ore, and the separation of the earthy matter in the form of scoria, the latter, which from its smaller specific gravity floats on the melted metal, is removed from the furnace through an aperture provided for the purpose; and the lead is allowed to run into a large iron pan, from which it is ladled into cast-iron moulds. It then constitutes what is called *pig*-lead. The scoria still contains a portion of lead, and is subjected to the heat of another furnace, called a slag-hearth, for its separation, which occurs upon its fusion; the metal then falls into a cavity, whence it is run and also cast into pigs.

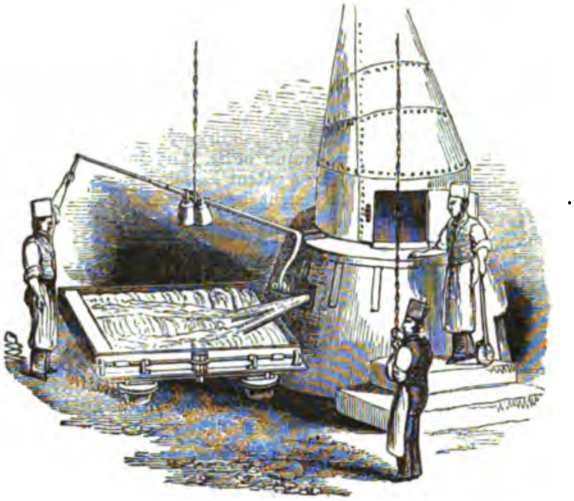
Before tracing the lead to its employment in manufactures, we must notice a very remarkable reward which ingenuity has reaped. The pig-lead always contains more or less of silver. The proportion is sometimes exceedingly minute, being not more than one ounce per ton in the metal raised in Derbyshire and Shropshire, while in every ton of the lead from Devon and Cornwall there is found from 20 to 40 ounces of silver: in some instances very much more. The produce of other mines contains the more precious metal in various proportions between these two extremes. The extraction of the silver is always performed when it exists in a proportion sufficient to pay the expense of the process, which varies in different localities according to the cost of fuel. The process of extraction, which is called *refining*, depends upon the well-known circumstance that lead, when heated to redness, absorbs a large portion of oxygen from the air, and is converted into an oxide; while silver does not undergo any such change, but retains its metallic form at almost any temperature. A *cupel*, which is a shallow dish of adequate dimension, is filled with a mixture of burnt bones and fern ashes pressed down, upon which the lead to be refined is placed in the furnace. As soon as the lead is melted, a blast of air, introduced by the usual means, is made to play forcibly upon the surface. In a short time a crust of yellow oxide is formed, which is driven away as fast as it appears to the opposite side of the furnace, until all or nearly all the lead has been thus converted to an oxide. The silver, which remains behind, is still combined with some portion of lead, and must be subjected to a second process similar to that here described, in order to liberate it in sufficient purity. The litharge, into which the lead has been thus converted, is easily restored to its metallic state by again heating it in a furnace in combination with carbonaceous matter, to which it gives up its oxygen.

This process, although valuable to a certain extent, is defective. There is a considerable waste of material when thus treated, varying according to the quality of the lead. The oxide is very volatile at high temperatures; and so much of it escapes in a vaporous form during the process of refining, that the difference of weight before and after its completion is on the average about two-fifteenths. Under these circumstances, a very beautiful process was brought forward in 1829 by the late Mr. Hugh Lee Pattinson. As a poor boy employed in a small chemist's shop at Alston, he became familiar with the operations at the lead-works in the vicinity of that town; and in after years this experience led him to the *crystallising* method of extracting silver from lead. Having observed that, in a mass of melted lead, crystals were formed as the temperature was diminished below the point of fusion, Mr. Pattinson conceived that these crystals might be more homogeneous, and would consequently be united with a smaller proportion of silver, than the remaining uncrystallised mass. This idea, proving upon experiment to be correct, has been made practically useful by subjecting the lead to repeated processes of crystallisation by means of a simple apparatus. This consists of a series of hemispherical iron pots, each capable of holding five tons of lead, ranged side by side, and furnished with separate fireplaces. The mode of operation is as follows:— One of the pots is charged with lead, and when this is melted, the surface is skimmed in order to remove such impurities as are thrown up. The fire is then withdrawn, and the lead is suffered to cool gradually. When the process of crystallisation begins, the crystals are withdrawn by means of ladles with perforations to allow the uncrystallised part to run through. These crystals are transferred to the second pot, where they undergo a second melting and crystallisation, and subsequently a third in another pot. This is continued until the crystals collected are found to contain no more than from 10 to 15 dwts. of silver per ton, and are consequently melted and cast into pigs for sale as refined lead. The process here described is repeated with the remaining portion of the lead until it is so rich in silver as to contain from 300 to 500 ounces per ton, after which the silver is extracted by the old process of cupellation. As the proportion of lead to which the cupelling process is applied does not exceed one-twentieth of the whole quantity of metal, the loss is diminished in a like proportion; by which means the expense of the extraction of silver is so far economised, that it will answer to apply the process to lead which originally contains any proportion greater than three ounces of silver to the ton.

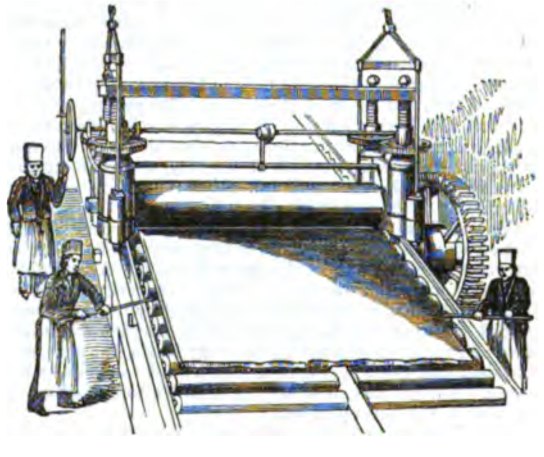
There is much that is interesting in this process. Not only is there a great saving of lead, but the silver extracted is considerable in amount. Shortly after Mr. Pattinson's death, in 1858, it was stated that his crystallising process has been the means of adding 200,000 ounces to the silver annually produced or extracted from English ores.

We shall now notice a few of the principal manufactures connected immediately with this metal—such as *sheet lead, lead pipes, lead shot, litharge, red lead,* and *white lead.*

To make *sheet lead,* the pigs are brought to a state of fusion in a large pot or cistern, near which is placed the table on which the sheet is to be cast. These pigs are about three feet long by six inches wide, and weigh about 170 pounds each. Two methods of making sheet lead are adopted, *casting* and *rolling.* In the casting method, the table, which is usually from 18 to 20 feet long and six feet wide, was formerly made of wood; and indeed wooden tables are still frequently used, but in many works cast-iron has been substituted. The wooden table has its surface protected by a layer of fine sand, which is wetted and spread evenly and firmly over it before the melted lead is poured on. To prevent the lead from running over the sides a ledge is provided, two or three inches thick, and two inches high, which forms the margin of the table. An instrument called a strike is also provided to regulate the thickness of the sheet, and to spread the melted metal evenly over the table. This strike, which is made wider than the table, rests by its two ends on the ledges; the size or diameter of the part within those ledges being adjusted according to the intended thickness of the sheet, which will be equal to the distance between the lower side of the strike and the layer of sand. In casting the sheet, the fused metal is taken from the cistern with an iron ladle, and put into a triangular shaped iron shovel or peel, placed at the head of the table, which peel being raised so as to pour out the lead upon the table, the strike is brought into use to spread it evenly over the whole surface; the surplus, if any, falling into a vessel placed for its reception at the foot of the table. Sheet lead of different thicknesses is described by those who use it as being of so many pounds weight to the superficial square foot. The usual kinds for covering roofs and gutters vary from about $\frac{1}{10}$th to $\frac{1}{8}$th of an inch in thickness, with a weight varying from about 6 pounds to 12 pounds per square foot. In the method of making sheet lead by *rolling,* the lead is first melted in a very large vessel which will contain six tons; from this, when freed from all impurities, it is allowed to flow through an opened valve into a cast-iron frame called the mould, about six feet square by six inches deep. The lead, thus cast into a thick block, is, when cold, lifted out of the mould by a crane, and placed in the lead mill. This mill consists of two ponderous iron rollers, between which the lead is made to pass by steam power, and an iron frame with wooden rollers to facilitate the movements of the lead; the passage is repeatedly made, until the metal is brought down to the required thickness. For some kinds of sheet-lead the successive rollings or millings amount to as many as eight hundred, by which the length is increased from six feet to four hundred feet.

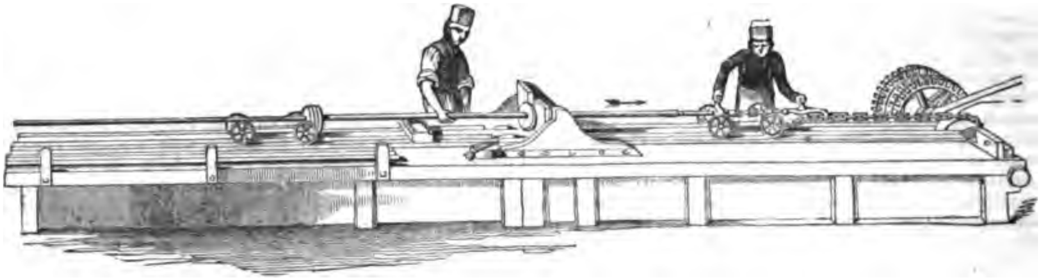


Lead Foundry.



Lead Rolling Mill.

Lead pipes are sometimes made, when great exactness of shape is not required, by bending a length of sheet-lead of the necessary width over a mandrel, and soldering the edges together. The more usual method of manufacture, however, is by casting and drawing. The casting-box employed is an iron cylinder made in two parts, and put together longitudinally with flanges; inside of this cylinder is placed an iron rod or core, which is so fixed as to be concentric with the cylinder without touching it; a space is thus left, into which the melted lead is poured. When this is set, the core is removed and the cylinder opened, so as to withdraw the pipe. The pipe being in its present state much thicker than is needed, must be lengthened, while its substance is reduced, by drawing it through a succession of holes in steel plates, diminishing gradually in diameter, similarly to the method adopted in drawing iron rods. The machinery employed for this process has at different times been much improved in its construction; so that it is now of rare occurrence to meet with an imperfect pipe.



Drawing Bench for Lead Pipe.

Lead shot is made by pouring the melted metal from a great height into water. This process was invented in 1782 by a workman named Watts, residing at Bristol; who is said to have conceived the idea in a dream, and to have proved its practicability by pouring some melted lead from the tower of the church of St. Mary Redcliffe at Bristol. Having secured the invention by a patent, he sold it to parties possessed of adequate capital; and the patent having long since expired, the process is now in common use. In order to give to the lead the quality of assuming a more perfectly globular form in cooling, the metal is previously alloyed with 2 per cent. of arsenic, or with a small quantity of mercury, which latter is used in order to obviate an objection caused by the poisonous quality of arsenic. Shot formed by granulation are made in a high tower, in the top of which the melting-room is built. Close to the furnace is placed a large colander or perforated plate, into which a portion (determined by experiment) of the scoria produced in melting the metal is placed; after which the metal is ladled into it. Being somewhat detained by the scoria, the lead is partially cooled and divided into separate portions, which pass through the colander in the form of globules; these globules follow in such rapid succession as to have the appearance, to a cursory observer, of a continued stream. The globules fall into a vessel of water placed on the lower floor of the tower. Near Newcastle, deserted coal-pits are used instead of lofty towers. At New York, lead shot are made in a building of moderate height, with a blast of air constantly rushing upwards; this quickens the cooling, and the shot are said to comprise a smaller number of defective globules. Under any system of manufacture, however, the shot are of various sizes, and a small proportion are imperfect as regards sphericity. Having been perfectly dried by artificial heat, they are sorted according to their sizes by means of a series of sieves, the meshes of which have different degrees of fineness. A sieve having the smallest mesh is first used, that the smallest sized shot may pass through and be collected. What remain are transferred to the sieve next in fineness, to separate shot of of the second size, and so on in succession. The process of separating the imperfect shot is very simple. A shallow wooden tray is suspended by cords from the ceiling of the room, and into this a certain quantity of shot is put. By raising one end of the tray, and giving it a motion from side to side, the shot will roll about: such as are perfectly spherical finding their way off the tray into a reservoir placed at its lowest side; while those which are of imperfect form run against and are detained by the sides of the tray, so that they can be collected in a separate vessel after the perfect shot have all run off. A very delicately constructed machine is now used in some shot-works instead of this tray. The shot thus sorted are then polished by putting about half a ton together into an iron barrel which that quantity will nearly fill. By means of a rotary movement given to the barrel, the shot are made to rub against each other, and thus acquire a black colour and a lustrous appearance. The finished shot, varying from $\frac{1}{8}$th to $\frac{1}{30}$th of an inch in diameter, are finally tied up in bags.

Litharge, *Red-lead*, and *White-lead* are compounds, the chemical nature of which has been noticed in connection with the chemistry of lead; we treat here simply of a few manufacturing details. Litharge is produced in the act of cupellation for extracting the silver, already described. It is used in the making of flint-glass; and in preparing certain salts of lead which are employed in dyeing and calico-printing; or, when mixed with coal and heated in a furnace, it may be made to yield up its metallic element, which is then called *refined* lead. *Red-lead*, or minium, is made by the medium of a reverberatory furnace. The pigs of lead are melted in these furnaces, and while in a fluid state, the metal is raked and stirred by means of an apparatus suspended from a chain, and held by a workman. The stirring continues several hours, by which time the metal, through imbibing oxygen, has lost its fluidity, its whitish colour, and its metallic lustre, and has become a grayish-yellow powder. A further process separates a small portion of unchanged lead from the powder, which then becomes a yellow pigment called *massicot;* and this massicot, by a second exposure to the reverberatory furnace, becomes converted into the still more useful pigment red lead. *White-lead* forms the basis of nearly all the pigments used by the house-painter. It is very unwholesome, giving rise to a disease called the *painter's colic* [PAINTER'S COLIC], and attempts have frequently been made to supersede it by other substances, but it still remains the staple article of the trade. It is a carbonate of lead, and is produced in various ways; but the usual process in the Newcastle district is the following. In a large square room ashes are laid on the floor; then a thick layer of tanner's spent bark; then a series of earthen pots, each containing about a pint of vinegar; then a series of small plates of sheet-lead, covering the open mouths of the vinegar-pots; then a layer of boards; then a second layer of tan; then a second series of vinegar-pots, covered by a second series of leaden plates—and so on: until a pile 20 or 30 feet high is built up. The room thus filled often contains 10,000 or 12,000 pots of vinegar, covered by three or four tons of lead; and in a large factory there may be ten or a dozen of such rooms. The room is then closed, and is kept closed for many weeks. The tan gives forth heat enough to induce chemical action, and an intricate series of decompositions and re-compositions follow. The result is, that the lead combines with oxygen and carbonic acid to form a flaky white substance, which, after a few more processes, becomes *white-lead*—sold either as a dry earthy substance, or as a kind of thick paste ground up with linseed oil. The late Mr. Pattinson was among those who introduced substitutes for white-lead. One was an oxychloride, made from a solution of chloride of lead with a solution of lime, soda, or other alkali.

In the lead trade, the imports, which are only small, are almost wholly from Spain, the produce of exceedingly rich mines situated at Adra in Granada. The quantity furnished by these mines varies much; their greater or less produce has a great influence upon the price of lead in every market of the world; and at times has acted injuriously upon the mine-owners in this country. The home produce was about 78,000 tons of ore in 1848, yielding 55,000 tons of lead; and 97,000 tons of ore in 1857, yielding 69,000 tons of lead—the ratio being about 70 per cent. of lead in the ore. England produces three-fourths of all the lead ore raised in the United Kingdom. At the prices of 1857, the lead was worth about 1,500,000*l.*, besides the silver extracted from it. The Alston district, on the confines of Northumberland and Durham, yielded the largest return in 1857 (17,000 tons); but Cornwall gave the richest per-centage of silver, averaging 37 ounces to the ton. The imports of lead (pig and sheet) in 1858, were about 14,000 tons. The exports in the same year were about 20,000 tons; besides 6000 tons of white lead, red lead, and litharge.

LEAD-LINE. Ships are said to be *in soundings* when the sea bottom can be reached by a weight lowered from a ship with a line attached. Of late years the depths at which this can be conveniently done have increased in extent. Lead-lines are carried by every ship or vessel afloat; and are either called *hand lines* or *deep sea* (or "dip sea") *lines*. The hand-lead weighs usually about 7 lbs., and its line varies in length from 20 to 35 fathoms, or sometimes 40 fathoms, being marked as follows:—

At 2	fathoms	from the	lead,	with a strip of black leather.
3	„	„	„	with ditto notched.
5	„	„	„	with a piece of white rag or bunting.
7	„	„	„	with a piece of red rag or bunting.
10	„	„	„	with a wide strap of leather with a hole in it.
13, 15, and 17, as at 3, 5, and 7.				
20	„	„	„	a cord with two overhand knots.
25	„	„	„	a cord with a half knot.
30	„	„	„	a cord with three overhand knots.
35	„	„	„	a cord with a half knot.
40	„	„	„	a cord with four overhand knots.

The marked depths are called *marks*, the unmarked are called *deeps*. Hence we say "*by the mark* seven," but "*by the deep* nine," &c., and for portions of a fathom in shallow water we denote (say, for instance) 3¾ and 4½, by the words "quarter less four" and "*and* a half four," &c.

A good leadsman will swing the lead over his head and throw it well forward, so that it may reach the bottom by the time the ship's motion brings it abreast the gangway, when he dexterously feels the ground and gets his "cast," and reads and sings the true depth. It is usual to have a hollow in the bottom of the lead filled with tallow, to which loose substances at the bottom adhere, and show the nature of the bed of the sea; this alone frequently acquaints a mariner with his ship's position.

The heaving of the lead forms one of the most interesting, as it is often one of the most intensely exciting, of all nautical operations, and it is so important that the Board of Trade have attributed the loss of a large amount of life and property to a neglect of it. It has been the theme of heart-stirring song and the plaintive voice of the leadsman calling the depths with studied professional tone and precision, as he feels beneath him the distance of the hidden danger, still enchants the ear of the evening wanderer upon coasts along which the sailor stems his way. To those even who are ignorant of the nature of the operation of sounding, the peculiar harmony of the leadsman's song acts like a momentary spell upon the sense, and arrests the step until the last note expires, and the evening or night resumes its stillness.

LEAGUE, LEUCA, LEUGA, LEUVA, LEWEKE, &c., an itinerary measure, which in modern English always means the twentieth part of a degree of latitude, or three of what are called geographical miles, each of which is the sixtieth part of a degree. The variation of the degrees of latitude is not sufficient to make this measure sensibly incorrect for nautical purposes; and the league of our sailors may be described and easily remembered as 3·456 statute miles of 1760 yards each. The same marine league is used by the French and other nations; besides which, the French have among their itinerary land measures two distinct leagues (or *lieues*, in some of the provinces *lègues*), the first of 2000 toises, or 2·42 English statute miles, which is the legal posting measure; the second of 25 to the degree, or 2·77 English miles. These are selected from among the French measures for their celebrity, and not as being the only ones; for before the Revolution there was no legal itinerary measure, and the length of the league varied from province to province. (Paucton.)

The *leuca* of the ancient English law writers is necessary to be determined before the rights given by many charters can be defined; but unfortunately the length of this measure is enveloped in utter confusion. The modern lawyers, we believe, evade the question by setting it down as a mile; thus the legal minimum distance between two markets, which was certainly 7 leucæ, is now called 7 miles. We shall, in the present article, collect a few testimonies on the length of the leuca, and must leave the reader to form the best opinion which he can upon the varying presumptions which they afford.

By citations in Ducange, Paucton, &c., it appears that Hesychius distinctly describes the λεύγη,* and Jerome, Jornandes, &c., the leuca (stated by Camden to be derived from the Celtic *leach*, a stone) as a Gaulish measure; and the original Gallic league was set down by the Romans as a mile and a half of their own measure, which was in all probability a rough estimation, first used in the Itinerary of Antoninus. In that work the distances from place to place in Gaul are frequently given in leagues (always in whole numbers), which are in every instance reduced to Roman miles at the rate of a mile and a half to each league. (See also Amm. Marcell., xvi., c. 12.) Hence, taking the Roman foot at 11·62 English inches (which is a mean between the most trustworthy measures) and the pace of 5 feet at 58·1 inches, the Roman mile of 1000 paces is 1614 English yards, and the leuca was therefore 2421 yards, subject to the error of the Roman estimation; or 1·376 modern English miles, with the same reservation.

This leuca in all probability was brought by the Normans into England. It is true that the Saxon charters of Ingulphus describe distances in leucæ; but the genuineness of these charters is now considered more than questionable, and perhaps this very circumstance is a presumption against them.

The evidence against the genuineness of the history of Ingulphus, when all put together, looks very strong. (Wright, 'Biog. Brit. Lit.,' Anglo-Norman period, p. 28.) There is nothing to set against it except our knowledge that the reaction against a work which has once been received, when suspicion of forgery arises, is strong and even bitter: a modified conclusion may possibly be arrived at in time. It must be remembered, also, that the same research which has thrown doubt upon Ingulphus has detected much tendency to Normanism in England even before the invasion by William: how much, is perhaps hardly known. It may therefore possibly be that the leuca was to some extent used in Saxon England.

The leuca soon began to vary in size. Ducange cites an old metrologist who speaks of two leucæ, the one legal, of 3000 paces, the other common, varying much in different countries. In the confusion incident to our subject, it will be worth while to remember that it was not uncommon, when a measure was found too short for convenience, to double it without altering its name: thus among the list of old coins (1540) given by John Dee, is found the *penny of two pence*. The registers of Battle Abbey (Sir H. Ellis) and the 'Monasticon Anglicanum' (Ducange) describe the leuca as containing 12 quarantenæ, or furlongs. Now the furlong (forty-long) is always 40 perches, and the perch, though varying much, yet was settled very early at 16½ feet. This gives a modern statute mile and a half to the leuca; so that a certain set of old authorities countenance the notion that the leuca was in their time very little more than that of the Gauls. It is not worth while to take into account any possible variations of the foot, since all the information we can obtain is too rough even to make the whole difference between the Roman and modern English foot of consequence.

The earlier statutes do not define the itinerary measures; confining themselves entirely to those by which land and goods were bought and sold. And the itinerary measures seem to have been on the increase, perhaps for the following reason: the jurisdiction of towns, monasteries, &c., was usually defined as extending a leuca or a given number of leucæ in every direction from their precincts, so that it became the interest of these powerful bodies to make the leuca as long as possible. The old French term *ban-lieue*, *banni-leuca*, or league of the edict or regulation, refers to the space over which jurisdiction was granted. Ingulphus, or his personator (for such a fact the two are almost equally good authorities), perhaps lets us a little into the secret when, speaking of his own monastery, he says, "Prudentissimi metatores, contra malitiam emulorum nostrorum piissimé providentes, potius plus quam minus ponere voluerunt." The same Ingulphus informs us that in his time the usual league was of 2000 paces, or 1·835 modern English miles, if the Roman pace be meant: but he adds that the English, adopting a Norman word to their own measure, frequently spoke of leucæ when they meant miles. But it may be questioned whether the mile and the leuca ever became interchangeable words in writings or charters, at least in England: in several Continental countries the term mile never became vernacular, and *miliare* is therefore translated by league.

There is sufficient evidence to show that, whatever the mile of a later date may have been, the leuca was generally two miles, though instances occur in which it is still described as 1500 paces. The following are extracts with which we have been favoured from manuscripts in the British Museum. In the registers of the monastery of Canterbury (of the 14th century) we have the following:—"Mensura unius pollicis incipit ex transverso radicum unguinum pollicis. Tres pollices unam palmam faciunt: quatuor palmi faciunt unum pedem. Pes et dimidium faciunt cubitum parvum: Sex parvi cubiti faciunt cubitum magnum. Quinque pedes faciunt passum unum. Centum viginti quinque passus faciunt stadium unum. Octo stadia faciunt unum miliare. Duo miliaria faciunt unam leucam." This gives a leuca of 10,000 feet. Again, in the same manuscript: "Memorandum quod virga communis continet xvi. pedes et dimid. videlicet quinque ulnæ et dimid. secundum standardum Regis. Idem xl. virgat. continent i. quarantenam. Item vii. quarantenæ et dimid. iii. virgat. et ii. palm. continent unum miliar. Item duo miliar. continent i. leucam." This gives a leuca of the same length. In a manuscript supposed to be of the time of Edward IV. we find "v. fote make a pase, and ther go viii. forelongs to a mile in Yngland, and ii. ynglysch myle make a ffrenshe leweke."

Bracton (Henry III.) and Fleta (Edward I.?) both assert (see the citations in Cowell, Comyns's 'Digest,' &c.) 6 leagues and half a league and the third part of a half (or 6⅔ leagues) as being the distance between two markets which do not injure each other; because 20 miles is a reasonable day's journey: now (both of them say) if the *dieta*, or day's work, be divided into three parts, the first is for going to the market, the second for business, and the third for returning. This appears to mean that no market should be established within a third of a day's journey of any one who is already within a third of a day's journey of the established market, so as to give him the option of going to either; that is, the two markets must be at least ⅔ of 20 miles apart, which being further described as 6⅔ leagues, shows that the leuca is 2 miles. This quotation is important, as establishing the meaning which the old law writers attached to the word.

It may then, we think, be confidently asserted, that the league, which began as a mile and a half (Roman), soon became lengthened, until it remained fixed at two of the miles of the day. It appears, also, that this length of 2 miles was a settled league at so early a period, that it is the measure of our oldest law writers, and of most of the oldest charters. It depends, therefore, upon the mile of the 13th and 14th centuries; and we must refer to the article MILE for the discussion of its absolute length. In order that matters of computation very nearly related may not be separated, we refer to that article some independent evidence on the length of the league, which makes no mention of the mile. We shall finish this article by stating our conviction that the length of the league or leuca was, in the time of the old law writers, very near, one way or the other, to two modern statute miles and nine-tenths of a mile: the old mile being to the modern statute mile in the proportion of 145 to 100.

LEAP YEAR, the name given to every fourth year of the Julian calendar, in which one additional day (a twenty-ninth day of February) is reckoned. This correction constitutes the distinction of the Julian calendar: the necessity for the Gregorian correction arises from the years being made a very little too long, one with another, by making them consist of 365¼ days each, as is done when a day is added to each fourth year. The Gregorian correction is made by omitting three leap years in four centuries, and it is settled that the common years, which would otherwise be leap years, shall be those which terminate centuries in which the first pair of figures is not divisible by four. Thus the years 1800 and 1900 are not leap years, but 2000 is leap year; 2100, 2200, 2300 are not leap years, but 2400 is leap year. [KALENDAR.]

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* The reading in Hesychius is, Λεύγη, μέτρον τι γάλακτος. We do not know who made the correction Γαλατικόν, but this word or Γαλάταις is probably the right reading.

LEASE. A lease, or letting, is sometimes called a demise (demissio.) It is sometimes said that Lease is from the Latin "locatio;" but as the verb which corresponds to the noun Lease is Let, it seems that the word Lease is the noun which corresponds to the verb Let. The verb let is akin to the French "laisser," and the German "lassen."

He who lets land is called the lessor, and he to whom land is let is called the lessee.

There are various legal definitions of a lease. A lease has been defined to be a conveyance of lands or tenements from lessor to lessee for life, for years, or at will, generally in consideration of a rent or other annual recompense to be paid by the lessee to the lessor. The reservation of a rent is not essential in a lease; but payment of rent is now the chief condition on which lands are let.

To constitute a lease, it is necessary that the lands must be let for a less time than the period for which the lessor has an interest in the lands demised. If a man parts with all his interest in the lands or tenements, the conveyance is an assignment, and not a lease. The relation that is created by a lease between the lessor and the lessee is usually expressed by the phrase landlord and tenant. The lessor has a reversion in the lands which are demised, that is, after the expiration of the lease the land reverts to him. The lessor, by virtue of this reversion, seignory, or lord's title, has the power of distraining on the land for the rent which is agreed on, and for the services which may be due by the terms of the lease; and fealty is always due to the lessor. The ordinary lease is that for a term of years, by which lease a rent, generally payable in money, at stated times, is reserved to the lessor. These stated times are usually quarterly periods.

The words used in a lease for the purpose of conveying that interest in the lands which constitutes a term of years are "demise, grant, and to farm let." These words are derived from the law-Latin expressions "demisi, concessi, et ad firmam tradidi." The word "firma," farm, is said to signify originally "provisions," and "to farm let" does not properly signify to let to be farmed, in the modern sense of the term, but to let on the condition of a certain rent being paid in farm, that is, in provisions. If this explanation is correct, a "farmer" is one who had the use of lands on condition of paying a "farm" or rent in provisions, such as corn and beasts. But the word "farm" now signifies the lands which a man hires to cultivate upon the payment of a rent.

The interest which a man acquires in land by a lease for years is a term of years, or an estate for years. The word lease is used in common language also to signify the estate or interest which the lessee acquires by the lease; but the word lease signifies properly the contract or conveyance by which the lessee acquires the interest in the lands.

The words "demise," &c., above mentioned, are the proper words to constitute a lease for years: but any words are sufficient, which clearly show "the intent of the parties that the one shall divest himself of the possession (of the land), and the other come into it for a determinate time." When the written contract was not intended to be a lease, but an agreement for a future lease, it was often difficult to determine whether the contract were not so expressed as to make it a lease.

At common law, it was necessary for the lessor to enter on the lands in order to make the lease complete, and no writing was necessary. But the Statute of Frauds (29 Car. II. c. 3, § 1) enacted, that all leases, estates, interests, of freehold or terms of years, created by livery and seisin only, or by parol, and not put in writing and signed by the parties so making the same or their agents thereunto lawfully authorised by writing, shall have the force and effect of leases or estates at will only, except leases not exceeding the term of three years from the making thereof, upon which the rent reserved to the landlord during such term shall amount to two-thirds at the least of the full and improved value of the thing demised. The Act 8 & 9 Vict. c. 110, enacts that a lease required by law to be in writing made after Oct. 1, 1845, shall be void in law unless made by deed.

The word "lands," which refers to the subject matter of a lease, comprehends what is upon the lands, as houses and other buildings, though houses and buildings are generally mentioned specifically in the lease.

The law of leases comprehends a great number of rules, which may be conveniently reduced to the following general heads:—

1. The things which may be subjects of leases.
2. The persons who may grant leases, and their powers to grant.
3. The form of leases, and the legal construction of the agreements contained in them.

The examination of these subjects belongs to treatises on Law. The article 'Leases and Terms of Years,' in Bacon's 'Abridgment,' is generally referred to as a good compendium of the law. A lease may contain any agreements that are lawful. The object of the present article is to consider what agreements farming-leases should contain or should not contain, in order that the lease may be most beneficial to the landlord and the tenant, and by consequence to the public generally.

The chief subjects of leases are houses and buildings of all kinds, cultivable lands, and mines. Many persons who have not the complete ownership of houses and lands are enabled to grant leases under particular powers; and there are many statutes under which particular classes of persons are enabled or restrained as to the granting of leases such as bishops, deans and chapters, and others.

The kind of leases of which we shall treat here are farming leases, which are granted by persons who have full power to grant them on such terms as they please. The particular form of such leases, as already intimated, is a matter that belongs to the subject of public economy, and it is almost beyond the province of direct legislation.

At present a great part of the land in England and Wales is held by large proprietors, and the number of land-owners who cultivate their own estates is comparatively small. In many parts of the kingdom the number of small land-owners who cultivate their own farms has certainly been decreasing for some centuries, and they are probably fewer now than in some former periods of our history. In England the great sub-division of land has been prevented by the form of government and the habits and feelings of those who have had the chief political power: and the great increase of wealth that has arisen out of the manufacturing and commercial industry of the country has tended to prevent the subdivision of land and not to increase it. Those who acquire great wealth in England by manufactures and commerce generally lay out a large part of it in the purchase of land; for the ownership of land is that which enables a man to found a family and to perpetuate it, to obtain social respect and consideration, and also political weight in the administration of public affairs. It facilitates his election to the House of Commons, and if he plays his part well, it may introduce him in due time to the House of Lords, and place him among the nobility of England.

Those who cannot acquire land enough to give them political weight, are still anxious to acquire land as a means of social distinction, and as a permanent investment which must continually rise in value. Thus there is a constant competition among the rich for the acquisition of land, which raises its price above its simple commercial value; and a man of moderate means does not find it easy to purchase land in small quantities and on such terms as will enable him to obtain a proper remuneration for the cultivation of it.

The great mass of the cultivators in England are now tenant farmers, who hold their land either by leases for years or by such agreements as amount to a tenancy from year to year only; and there is the like kind of competition among them to obtain land upon lease, that there is among the wealthy to obtain land by purchase. The consequence is that more rent is often paid for land than it is worth: a consequence of the limited amount of land and of the number of competitors for it. This circumstance, however, combined with others, enables the landlord to impose conditions which are unfavourable to the tenant and to agriculture, and finally to himself.

Several things are essential to the good cultivation of land, whether it is held by lease or is the property of the cultivator. These essentials are, a knowledge of the best modes of husbandry, adequate capital, and a market in which the farmer may freely buy and sell all that he wants. Now, in the present state of agriculture in this country, not one of these three conditions exists in the degree which is necessary to ensure good cultivation. The greater part of the land in England, as already observed, is cultivated under leases or a tenancy from year to year; and the covenants in the leases are often such as to be an insuperable obstacle to good agriculture. The condition then of the tenant farmer, as determined by his lease, is that which we have to consider.

Many landholders have several objects in view in letting their lands besides the getting of rent. One of these objects is to maintain their political weight by commanding the votes of their tenantry; and this is mainly effected by not granting them leases of their lands for determinate periods, such as seven, fourteen, or twenty-one years; but by making them very nearly tenants at will, or liable to quit at six months' notice. He who depends for his subsistence on having a piece of land to cultivate, out of which he may be turned on a short notice, will not be an independent voter. Nor can the landlord expect to have a good tenant who will improve his land and a political tool at the same time. The uncertainty of the tenure will prevent a man of skill and capital from investing his money upon so uncertain a return. There may be many cases in which the personal character of the landlord is a sufficient guarantee to the tenant that he will not be disturbed in the possession of the land, even where he has no proper lease, so long as he cultivates it fairly and pays his rent.

But the most intelligent landlords themselves admit that the only proper tenure of the tenant is that of a lease for a determinate period; and it is on this condition alone, as a general rule, that a landlord can get men of capital and skill to cultivate his land. It has been maintained by arguments which are unanswerable, that if lands were let to farmer tenants on leases for a determinate number of years, and on conditions which should not interfere with the land being cultivated in the best mode, there would be a great amount of fresh capital applied to the cultivation of the land, with all the improvements of modern husbandry. It is contrary to experience and to all reason to suppose that a good farmer will apply his skill and capital to improvement of another man's property, unless he has the security that he will be remunerated.

The improvements which would follow from a good system of leasing, would be the abolition of the evils which now exist in consequence of uncertain tenure and of bad leases. It is affirmed by the best authorities that the amount of capital which is now applied to the cultivation of the land in England is very inadequate, that a large part of the farmers have not sufficient capital to improve their lands, nor the necessary skill and enterprise; and it is maintained that these evils are mainly owing to the want of a sufficient security of tenure or the want of a lease, or, where there is a lease, to the absurd restrictions with which many of them abound.

It has been said, and truly enough, that there is no advantage to the landlord in granting a lease to bad cultivators, and that there are many such. Such a lease would not indeed be any advantage to the farmer himself or the community in general; but he who has land to let, and will let it on terms that are mutually profitable to the landlord and the tenant, will be much more likely to get a tenant of competent skill and capital, than he who gives the farmer an uncertain tenure or binds him in the fetters of a bad lease.

The preservation of the game and the enjoyment of the pleasures of the chase, or of the profits derived from the wild animals, is another object which some landlords secure by their lease with as much minuteness and strictness as they do their rent. [GAME LAWS.] Thus, in addition to getting a rent from his land, the landlord often wishes to command the votes of his tenant and secure his game. With reference to these objects and certain other imaginary advantages which he purposes to secure by directing the mode of cultivation, he has a lease drawn up with conditions, restrictions, penalties, and feudal services, which no care on the part of the farmer can prevent him from breaking in some particular, and which no man of capital, skill, and independent feeling would consent to sign.

But these farming leases are often copies of old leases, made in other days, and are unsuited to the present state of agriculture. The things which they require not to be done and those which they require to be done, are often inconsistent with good agriculture, or, in other words, they prevent the land from yielding that amount of produce which it would yield under the best system, not only without thereby being impoverished, but with the certainty of permanent improvement. Ignorance on the side of the landlord of his true interest is one of the reasons why many of these absurd leases still exist.

There can be no principle in the letting of land, if the object be simply to secure the best rent to the landlord and the permanent improvement of the land, which makes it different from the letting of any other piece of property. The good farmer hires land to cultivate, with the hope of deriving profit from the application of his skill and capital. He does not want the advice and direction of another man: he trusts to himself. The first object of the landlord is to get as much rent as his land is worth, and to secure it against deterioration during the tenant's occupation. The terms of the lease, then, should simply be the payment of the rent agreed on, and the observance of such conditions as are found by experience and known to practical agriculturists to be necessary to secure the permanent value of the landlord's land. It is admitted by all reasonable people that the landlord should have ample security by the lease for his land being given up to him at the end of the lease in as good condition as he gave it to the tenant. The tenant wants no directions from the landlord, and no conditions in his favour, beyond the simple condition of being allowed to cultivate the land in the best way that he can for his own profit during a period sufficiently long to secure him a return for his outlay; and he acknowledges that he must submit to all conditions in favour of the landlord which are not inconsistent with his free cultivation, and which shall secure the permanent value of the landlord's property. Perhaps many landlords who now grant hard leases would admit this general principle: but when they came to details, they would insist on many conditions as necessary to secure their permanent interest, which a good farmer would object to as not necessary for that purpose, and also as inconsistent with his profitable cultivation.

The framing of such a lease as we have described in general terms, must be the joint work of intelligent and liberal landlords and of good tenant farmers. It may require some time, some more experience, and suggestions from many quarters before such a lease is got into the best form. But it is an object worth the consideration of all persons interested in the cultivation of the land, and some attempts in this direction have been made already.

The covenants contained in a lease, however few they may be, often occasion difficulty and dispute upon the expiration of the tenancy. The landlord may often claim more than his due, and the tenant may be disposed to do less. These difficulties are not peculiar to farm tenancies; they occur continually in the case of dwelling-houses let for a term of years upon the condition of keeping them in good repair. If such disputes cannot be settled amicably, or by reference to arbitration, the only way is by legal proceedings. It has been suggested that in the case of dwelling-houses in large towns like London, some easy mode of finally settling such disputes might be established. In such cases, the evidence of surveyors is the evidence on which a jury must give their verdict in case of legal proceedings; and it would be quite as satisfactory to all parties, if the evidence that is submitted to a jury, for their judgment, were submitted to a few competent persons to be chosen in some uniform manner, and whose decision should be final.

In 1845 an act was passed (8 & 9 Vict. c. 124) entitled 'An Act to facilitate the granting of certain Leases.' Its object is to substitute abbreviated forms for those previously in use, and it is provided that in taxing any bill for preparing and executing any deed under the act, the taxing officer, in estimating the proper sum to be charged, is to consider 'not the length of such deed, but only the skill and labour employed, and the responsibility incurred in the preparation thereof.' It is enacted in section 4, 'That any deed or part of a deed which shall fail to take effect by virtue of this act shall nevertheless be as valid and effectual, and shall bind the parties thereto, so far as the rules of law and equity will permit, as if this act had not been made.' There are schedules to the act, one of which gives, in column 1, short forms of expression which may be used in place of the ordinary expressions in leases, which are contained in column 2; and it is enacted by section 1, "That whenever any party to any deed made according to the forms set forth in the first schedule of this act, or to any other deed which shall be expressed to be made in pursuance of this act, shall employ in such deed respectively any of the forms of words contained in column 1 of the second schedule hereto annexed, and distinguished by any number therein, such deed shall be taken to have the same effect and be construed as if such party had inserted in such deed the form of words contained in column 2 of the same schedule, and distinguished by the same number as is annexed to the form of words employed by such party; but it shall not be necessary in any such deed to insert any such number." This act does not extend to Scotland. The amount of words saved by this act is not sufficient to compensate for the difficulties that may arise from persons using the abbreviated forms in cases where they may not intend them to have the full meaning which this act gives to them. He who wishes to guard himself either as a landlord or tenant by suitable covenants will do better to express his meaning at full length, without availing himself of the abbreviated forms which this act invites him to use.

Leases in general require either an ad valorem stamp, now of very moderate amount, or the common deed stamp, without which the instrument cannot be given in evidence.

LEASE AND RELEASE. Recent legislation has swept away the mode of conveyance by lease and release, which was formerly almost universal. The importance which this legal device formerly had in the system of conveyancing, makes it necessary to give an account of it here. There are various kinds of release, but that intended in the phrase in question, is the relinquishment of some right or benefit to a person who has already some interest in a tenement, and such interest as qualifies him for receiving or availing himself of the right or benefit so relinquished. (Burton's *Law of Real Property*, 45.) Before the passing of the Statute of Uses "it appears that a lease for two or three years was sometimes made, and perfected by entry of the lessee, for the single purpose of his afterward receiving a release of the reversion. Thus arose a sort of compound conveyance, called a lease and release, which, if the grantor were seised in fee simple, had the same effect as a feoffment." (*Ibid.*, 62.)

When it had been determined that the Statute of Uses operated so as to give an estate in land without entry, a lease for a year by bargain and sale was made by the vendor to the purchaser. A use was thus raised to the bargainee, without any enrolment, which in the case of freehold interests was required by the statute of enrolments; and the use thus raised or created for the bargainee was converted, by the Statute of Uses, into a legal estate. Thus the bargainee became immediately capable of accepting a release of the freehold and reversion: and a release was accordingly made to him, dated the day next after the day of the date of the bargain and sale. The release made to a purchaser who has an estate by virtue of the bargain and sale may either be a release at common law as referred to in the passage just quoted, or it may be a release under the Statute of Uses, which is now always meant when we speak of the conveyance called a lease and release.

This conveyance is said to have been first contrived by Serjeant Moore, at the request of Lord Norris, in order that some of his kindred should not know, by any search of public records, what settlement he should make of his estate. The validity of it was formerly doubted. But it was resolved (18 Jac. I.) by the chief-justices Montague and Howard, and chief-baron Tanfield, that upon a deed of bargain and sale for years of land, though the bargainee never entered, if afterwards the bargainor makes a grant of the reversion, reciting the lease, to divers uses, it was a good conveyance of the reversion, (*Lutwich* v. *Mitton*, Cro. Ja., 604.) And in a subsequent case, where there was a bargain and sale for years, followed by a release, judgment was given, —'that the lease being within the Statute of Uses, there was no need of an actual entry to make the lessee capable of the release; for, by virtue of the statute, he shall be adjudged to be in actual possession.' (*Barker* v. *Keate*, 2 Mod., 249.)

In consequence of this interpretation of the law lease and release became the most common assurance for the transfer of freehold estates.

Only a nominal consideration was mentioned in the bargain and sale; and it was held that even a reservation of a pepper-corn rent was a sufficient consideration to raise a use by a bargain and sale on which to found a release.

The recital of a lease for a year, in a deed of release, was good evidence of such lease against a releasor and all claiming under him (but not against strangers), without proving that there was such a deed, and that it was lost or destroyed. Not only estates in possession, but estates in remainder and reversion were conveyed by lease and release. Estates in remainder and reversion expectant on estates for lives might be conveyed by lease and release; as also incorporeal hereditaments, such as advowsons, tithes, rents, &c., for they are expressly named in the Statute of Uses, or comprised under the general word hereditaments. (4 Cru. *Dig.*, 114, 115.)

Lease and release was one of those which were technically called *innocent* conveyances, in contradistinction to those which are termed *tortious*.

A conveyance by lease and release did not divest any estate, or create a discontinuance or forfeiture. Thus Littleton says:—"By force of a release nothing shall pass but the right which he may lawfully and rightfully release, without hurt or damage to other persons, who shall have right therein, after his decease." And in a subsequent section he says:—"If tenant-in-tail lets the land to another for term of years, by force whereof the lessee hath possession, and the tenant-in-tail release all his right in the same land, to hold to the lessee and his heirs for ever, this is no discontinuance: but after the decease of the tenant-in-tail, his issue may enter; for by such release nothing passeth but for time of the life of the tenant-in-tail."

The Act 4 & 5 Vict. c. 21, made the lease for a year unnecessary, and instead thereof it was only required that the act should be referred to in the releasing clause, which thereupon took the same effect as if the lease had been actually made. Subsequently the Act 8 & 9 Vict. c. 110, by enacting that corporeal tenements should be deemed to lie in grant as well as in livery took away all necessity for the legal device of a release; and the simple word grant now supplies the place of the old cumbrous machinery.

LEASE IN SCOTLAND. [TACK.]

. LEAST ACTION, PRINCIPLE OF. [ACTION, LEAST.]

LEAST SQUARES, METHOD OF. This is a method, which, since its first introduction, has been shown to be the method of finding the most probable truth, when a number of discordant observations have been made upon a phenomenon. The earliest attempt at anything of the sort was made by Cotes, in a tract entitled 'Estimatio Errorum in mixta mathesi,' in which he very distinctly recommends a process which is identical with that of the method of least squares. It is remarkable that Cotes proposes this theorem not merely as a mode of finding a convenient mean (as was done by Legendre and Gauss), but as giving positively the most probable result. He even introduces the hypothesis of observations having different weights (though not with perfect correctness), and comes as near as possible to the assertion afterwards proved by Laplace. It will be worth while to quote the passage, as follows:—'Mihi vix quidquam ulterius desiderari videatur postquam ostensum fuerit quâ ratione Probabilitas maxima in his rebus haberi possit, ubi diversæ observationes, in eundem finem institutæ paullulum diversas ab invicem conclusiones exhibent. Id autem fiet ad modum sequentis exempli. Sit p locus objecti alicujus ex observatione primâ definitus, q, r, s, ejusdem objecti loca ex observationibus subsequentibus; sint insuper P, Q, R, S, pondera reciprocè proportionalia spatiis evagationum, per quæ se diffundere possint Errores ex observationibus singulis prodeuntes, quæque dantur ex datis errorum limitibus; et ad puncta p, q, r, s, intelligantur pondera P, Q, R, S, et inveniatur eorum gravitatis centrum Z: dico punctum Z fore locum objecti maximè probabilem qui pro vero ejus loco tutissimè haberi potest.'

Legendre, in his work on comets (1806), first distinctly proposed the application of the method to any case, and Gauss afterwards stated that he had been in the habit of using it since 1795. Finally, Laplace, in his Theory of Probabilities (1814), and we believe in a previous paper published in the 'Memoirs of the Academy of Sciences,' showed that this method was in all cases the one which the principles of that theory pointed out as giving the result, which, from the observations, has the greatest weight of probability in its favour. The details and demonstration of this method may be found in the work of Laplace, cited in the Berlin 'Astronomisches Jahrbuch,' for 1834 and the two following years, and in the treatise on Probabilities in the Encyclopædia Metropolitana.

The most simple case of this method has been in use as long as accurate observations have been made, under the name of taking an average or a mean. If three observations give 93, 94, and 98, then the mean of the three is 95, and if this be assumed as true, it is also assumed that the errors of the observations were 2, 1, and 3. The sum of the squares of these is 4 + 1 + 9, or 14, and this is the least possible sum which can be thus obtained. If for example, we assume anything but 95, say 95·1, the assumed errors are then 2·1, 1·1 and 2·9, the squares of which are 4·41, 1·21, and 8·41, the sum of which is 14·03. more than 14.

But the more extended cases of the method of least squares are those in which the result is not simply observed, but is to be determined by operations upon the results of observation. In all cases the rule is the same: namely, that result has the greatest probability in its favour, the assumption of which makes the sum of the squares of the errors the least possible, provided that all the observations are equally worthy of confidence. Without entering into further explanation, we shall give the results of one case.

Suppose that A and a are to be determined by observation, the required result being $A \div a$, or the solution of the equation $a\,x = A$. Suppose also, which is essential to the simple form of the method which we now give, that all the observations, both of A and a, are made under equally favourable circumstances. Say that four observations are made of each; those for a being p, q, r, and s: those for A being P, Q, R, and S. If then all the observations were perfectly correct, each of the equations $p\,x = P$, $q\,x = Q$, $r\,x = R$, $s\,x = S$, would be identical with $a\,x = A$. Supposing, however, that the observations are discordant, take what value of x we may, the several quantities $p\,x - P$, $q\,x - Q$, $r\,x - R$, $s\,x - S$, will not be (as they should be) each equal to nothing. Whatever their value may be, the whole of each value will be error: and the sum of the squares of the errors, or

$$(p\,x - P)^2 + (q\,x - Q)^2 + (r\,x - R)^2 + (s\,x - S)^2$$

must be made the least possible. The value of x which satisfies this condition is

$$\frac{P\,p + Q\,q + R\,r + S\,s}{p^2 + q^2 + r^2 + s^2}$$

which is the most probable value.

The method of least squares is now universally used in astronomy, which is perhaps the only science in which so delicate a test is absolutely necessary.

LEATHER MANUFACTURE. Leather (*cuir*, French; *leder*, German; *leer*, Dutch; *læder*, Danish; *läder*, Swedish; *cuoio*, Italian; *cuero*, Spanish; *kusha*, Russian,) is prepared from the skins of animals, or, it would perhaps be more correct to say, consists of that substance after it has been chemically changed by the process of tanning. This change is effected by means of a substance residing in several vegetable matters, to which the name of *tannin* has been given. When this tannin, which is soluble in water, is applied to the hides of animals from which the hair, epidermis, and any fleshy or fatty parts adhering to them are removed, and which hides then consist wholly of *gelatin*, also soluble in water, these two soluble substances so unite chemically as to form the wholly insoluble substance called leather. The object of the tanning process is to produce such a chemical change in skins as may render them unalterable by the external agents which tend to decompose them in their natural state; and in connection with the subsequent operations of dressing, or currying, to bring them into a state of pliability and impermeability to water which may adapt them for the many useful purposes to which leather is applied. Effects in some degree similar are produced by forcing oil or grease into the pores of the skin, or by preparation with alum.

The preparation of skins by tanning or other analogous processes has been practised from the earliest times; and, although it has engaged the attention of several scientific men, and has been the subject of many curious experiments, it has received less modification from recent improvements in chemical science than many other manufacturing processes. Several plans have been suggested with a view to expedite the process, which, on the old system, is a very tedious one, but having been found to deteriorate the quality of the leather, they have been wholly or partially abandoned; and others, which appear to be more successful, are as yet adopted by a few manufacturers only.

Before noticing the tanning and currying processes, it will be desirable to glance at the chief kinds of hides and skins converted into leather.

Among the hides of *oxen*, those supplied by bulls are thicker, stronger, and coarser in the grain than those of cows; while the hides of bullocks are intermediate between those of the bull and the cow. The thickest and most substantial leather now in general use is that made from the hides of the half-wild cattle of South America. Such leather is employed for the soles of boots and shoes; for most parts of harness and saddlery; for leather trunks, buckets, hose for fire-engines, and pump-valves; for the thick belts used in military accoutrements; and for the gloves of cavalry. The thick *buff-leather* formerly used as armour, and which was pistol-proof, and would resist the edge of a sword, was made from the hide of the urus or wild bull of Poland, Hungary, and the middle and southern provinces of Russia; the animal itself being called *buffe*, whence the common name of the leather made from its hide. The skins of *calves*, though thinner than those of cows, are thicker than most other kinds of skin which are converted into leather. They are tawed or alumed for the use of bookbinders, and are tanned and curried for the upper leathers of boots and shoes. It was formerly customary, in the south-west of Ireland, to slaughter cows when in calf; and the celebrated Limerick gloves were made of the exceedingly fine and delicate skins of the unborn calves. *Sheep-skins* vary much in quality. A long fleece always indicates a thin skin; much of the jelly laid up in that organ being, perhaps, the material from which the fleece is elaborated. When simply tanned, sheepskins are employed for inferior bookbinding, for leathering bellows, and for various other purposes for which a cheap leather is required. All the *whit-leather*, as it is termed, which is used for whip-lashes, bags, aprons, &c., is of sheepskin; as are also the cheaper kinds of *wash-leather*, of which brushes, gloves, under-waistcoats, and other articles of dress are made. Mock or imitation morocco, and most of the other coloured and dyed leathers used for women's and children's shoes, carriage-linings, and the covering of stools, chairs, sofas, writing-tables, &c., are also made of sheepskin. *Lamb-skins* are mostly dressed white or coloured for gloves; and those of *goats* and *kids* supply the best qualities of light leather, the former being the material of the best morocco, of all colours, while kid leather, both white and coloured, affords the finest material for gloves and ladies' shoes. Leather from goat-skins, ornamented and sometimes gilt, was formerly used as a hanging or covering for walls. *Deer* and *antelope* skins, shamoyed or dressed in oil, are used chiefly for riding-breeches. Shamoyed leather breeches were formerly very much used, especially in the army; but being found unhealthy to horsemen exposed to much wet weather, they were superseded by cloth trousers, except in a few special regiments. *Horse-hides*, which, considering their size, are thin, are tanned and curried, and are used by the harness-maker, especially for collars; and occasionally, when pared thin, for the upper leathers of ladies' walking shoes. *Dog-skins* are thick and tough, and make excellent leather; but they have been in a great measure superseded, as a material for dress shoes, by horse-leather and by tanned rat-skins. *Seal-skins* produce a leather similar but inferior to that supplied by dog-skins; and *hog-skins* afford a thin but dense leather, which is used exclusively for covering the seats of saddles. *Porpoise-skins* have lately been made, in Canada, into strong and beautiful leather.

Tanning.—The larger and heavier skins operated upon by the tanner, as those of bulls, buffaloes, oxen, and cows, are technically distinguished as *hides;* while the name *skins* is applied to those of smaller animals, as calves, sheep, and goats. The process necessary to convert hides into the thick hard leather used for the soles of boots and shoes, and for similar purposes, will be first noticed. The hides are brought to the tanner either in a fresh state, when from animals recently slaughtered, or, when imported from other countries, dried or salted, and sometimes both, for the sake of preserving them from decomposition. In the former case the horns are removed, and the hide is scraped to cleanse it from any small portions of flesh or fatty matter which may adhere to the cutis; but in the latter it is necessary to soften the hides, and bring them as nearly as possible to the fresh state, by steeping them in water, and repeated rubbing or beating. After this the hair is removed; sometimes by steeping the hides for several days in a solution of lime and water, which has the effect of loosening the hair and epidermis, or outer skin; and sometimes by suspending them in a close chamber called a *smoke-house*, heated a little above the ordinary temperature of the atmosphere by means of a smouldering fire; in which case the epidermis becomes loosened by incipient putrefaction. In either case, when the hair and epidermis, or cuticle, are sufficiently loosened, they are removed by scraping with a curved knife, the hide being laid upon a convex bench, or 'beam.' The hides are prepared for the actual tanning, or immersion in a solution of bark, by steeping them for a few days in a pit containing a sour solution of rye or barley flour, or in a very weak menstruum consisting of one part of sulphuric acid mixed with from five hundred to a thousand parts of water. By this process, which is called 'raising,' the pores of the hides are distended and rendered more susceptible of the action of the tan, and the substance of the skin is apparently increased; but, as the process does not add to the gelatin of the skin, a hide which is much thickened by the raising process loses its substance when condensed by the shoemaker's hammer.

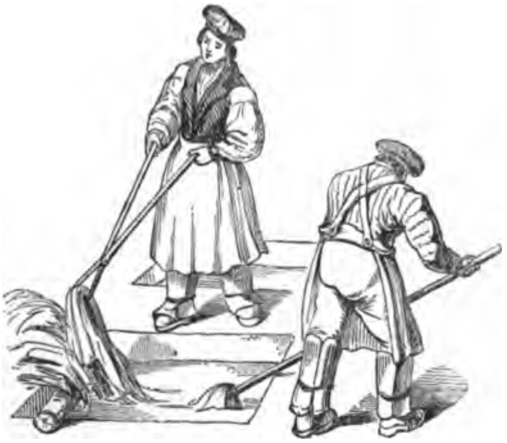


Fig. 1.—Steeping Hides and Skins.

Different tanners vary very much in the above processes. Some believe that much of the original gelatin of the hides is never combined with the tannin, but is wasted, owing to defective modes of liming, unhairing, and cleansing. The German tanners often adopt a process called *sweating*, by laying the hides in a pack or pile, and covering them with spent tan to produce a fermentative heat. On these points much remains yet to be discovered. There are also many variations in practice, in relation to the actual tanning, or conversion of the prepared pelt into leather. Oak bark, crushed or ground to a coarse powder in a bark-mill, is the substance most commonly used to supply the astringent principle. In the old method of tanning, which is not yet entirely abandoned, the hides and powdered bark were laid in alternate layers in the tan-pit, which was then filled with water to the brim. After some months the pit was emptied and re-filled with fresh bark and water; and this process was repeated whenever the strength of the bark was exhausted. In this way the time required for impregnating the hides varied, according to their thickness and other circumstances, from one to four years. The process has been greatly expedited by the improvements introduced in consequence of the experiments of M. Seguin, a French chemist; nevertheless it may be well to observe that skins which are quickly tanned, by the use of strong solutions, produce leather of less durable quality than that which is slowly formed: 100 lbs. of skin, quickly tanned in a strong solution of bark, will produce 137 lbs of leather, while the same weight of skin, slowly tanned in a weak solution, produces only 117½ lbs.; the additional 19½ lbs. in the former case tending to swell the tanner's bill, although it deteriorates the leather, and causes it to contain less of the animal solid.

The variations of practice among different tanners extend to the substance used as an astringent, as well as to the manner of applying it. Ground oak-bark, which was formerly the only material in common use, and is still the most general, produces good leather of a light fawn colour. Valonia produces leather of great solidity and weight, the colour of which is inclined to gray, and which is more impervious to water than that made with oak-bark. Catechu, or terra-japonica, produces leather of a dark reddish fawn colour, which is light, spongy, and very pervious to water. Another substance which has been used of late years is a kind of bean-pod, called divi-divi. These substances may be used either individually or in various combinations. In the methods of preparing tanning solutions there is also considerable variety. Some tanners use cold water for the purpose, and others hot water or steam; others again, instead of pure water, employ ooze, or tanning liquid which has been exhausted by use. A further point of difference is found in the strength of the solutions used, which vary exceedingly. When the impregnation of the hides with tannin is effected by laying them flat in the tan-pits, they are frequently taken out to renew the solution; and the skins which have lain near the top of one pit are laid near the bottom of the next, so as to equalise the amount of hydrostatic pressure. Sometimes the tanning is facilitated by suspending the skins vertically in the liquid, by which means they are penetrated quickly; but the plan requires considerable room, and, unless the skins are frequently moved, it occasions injurious folds in the leather. Another plan, which answers well for small light skins that require but a short time for tanning, is to sew up each skin into the form of a bag, to fill it with tan-liquor, and then immerse it in the pit. The great space required is the principal objection to this plan. In whichever of the above ways the tanning is effected, the hide is subjected to the action of solutions increasing progressively in strength, until it is so perfectly penetrated, that when cut through it presents a uniform brown colour; any appearance of a light streak in the middle of its thickness being an indication of imperfect tanning. When the process is complete, the hides are hung up in a shed, and allowed to dry slowly; and, while they are drying, they are compressed by beating or rubbing, or by passing them between rollers, to give them firmness and density. A yellow deposit is now found upon the surface of the leather, to which the name of bloom or pitching is technically given; and, although this deposit is subsequently removed by the shoemaker in the operation of buffing, and forms a useless addition to the weight and cost of the leather, the prejudice of purchasers requires that it be left on the surface by the tanner.

Although, owing to the many differences in the practice of tanning, no definite time can be stated for the various operations mentioned above, it may be observed that the usual period required for tanning such hides as are used for the soles of men's boots is from six to twelve months; and that from fifteen to eighteen months are required in preparing those of the thickest kinds, which are termed butts or backs. Occasionally hippopotamus hides are tanned, requiring an enormous time for the process; and instances have been known of wild boar hides remaining seven years in tan, to produce leather two inches in thickness.

Before describing the processes for thinner leather, it will be necessary briefly to notice some among the numerous plans for shortening the time involved in the tanning of thick hides. Several schemes have been devised for forcing a tanning solution through the pores of the hide by mechanical pressure. Mr. Spilsbury obtained a patent for this purpose some years ago; but it failed; for it appears that tannate of gelatin was formed on the outer sides of the skins in the form of long masses of slime; while the leather had lost much in weight, was very porous, and unequally tanned, in consequence of the tan-liquor penetrating most readily the thinnest or weakest parts of the hide. A process patented by Mr. Drake consisted in sewing two skins together (after they had received a slight tanning in the ordinary way), so as to form a water-tight bag, which was filled with tan-liquor. The bag thus formed was compressed between two vertical gridiron-like frames or racks, by which it was prevented from bulging at the sides, and the liquor was confined to a thin vertical stratum. The aqueous portion of the tan-liquor percolated through the hides; and this penetration of the leather was facilitated by heating the room so as to promote evaporation from the exterior surfaces of the bags or skins. In another somewhat similar plan, contrived by Mr. Cox, the hides were sewed up in the form of bags, and supported by a casing of canvas. In the process of Mr. Chaplin, the bags were laid in an inclined position, and turned periodically to equalise the action of the tan. In another plan, which has been tried under several forms, the tanning liquid is applied to both sides of the hides, which are placed in an air-tight vessel, and is forced into their pores by hydrostatic pressure, the air being previously pumped out. The operation may be repeated as often as necessary, with infusions gradually increasing in strength; air being allowed to fill the pores of the hide between each immersion. Mr. Cagswell's plan consists in laying the hides upon a quantity of sawdust, contained in shallow boxes, of which any required number may be arranged in a suitable framework, about twelve inches above one another. The hides are not laid flat, but have their edges a little raised, so that their upper surfaces form shallow troughs capable of holding a layer of the tanning solution, which must be replenished from time to time as it filters through the hide and the sawdust, or other soft porous substance upon which it is laid. The spent liquor runs off from the bottom of the box or trough, which is somewhat inclined for that purpose, into a vessel or channel provided for it. Messrs. Herepath & Cox's process is founded upon the principle of washing a sponge, by alternately allowing it to imbibe water, and then forcibly expressing it. The weak infusion, or ooze, is forced out of the pores of the hide before it is subjected to a stronger, so that the fresh ooze may be able to act more efficiently. This is effected by connecting a number of hides together by strings, so as to form a continuous belt, and passing them between rollers turned by steam or other power, while they are being removed from one solution to another. In order to produce a tolerably uniform belt or continuous sheet of hides, they are either placed alternately head to head and tail to tail; or, if laid across the belt, with the heads and tails towards each side alternately. The lower roller is about thirty inches in diameter, and is covered with horsehair cloth; and the upper roller, which is pressed against the lower one with any determinate degree of force by means of weighted levers, is only about eighteen inches in diameter, and is covered with woollen cloth. By this process a strong hide may be tanned more quickly than by the old method. Much attention has lately been paid to Mr. Preller's process, by which leather is now made at Bermondsey. The hides are first washed; then unhaired; then partially dried; and then covered uniformly with a paste or composition. This paste consists of starchy or glutinous matters, such as barley meal, rice flour, or starch, combined with an oily matter, such as butter, milk, oil, or grease. The paste is smeared on the flesh side of the hide, which is then put into a cylinder or drum, and rotated for some hours with steam occasionally admitted. The hides being taken out and dried, they are pasted and rotated a second and even a third time. At the end of this process they are found to be affected all through by a kind of substitute for tanning. It is said that an ox-hide may be tanned in this way in two days and a half, and a calf-skin in sixteen hours. It seems to be generally admitted that the leather thus made is light, pliable, strong, and durable; it is found useful for certain special purposes, such as driving bands for machinery, picks for looms, and for enamelling. A plan has been brought forward by Mr. Clarkson for so applying a solution of chloride of soda and alumina, and then one of tannin, as to give a *surface* of leather to the hide, sufficient for many useful purposes.

We might greatly lengthen this list of new processes, but these few will illustrate the whole; especially, as the old operations of the tan-pit have not yet been very extensively departed from in practice. Really good leather is still very slowly made. One inventor has gone so far to employ galvanic agency to drive the tan into the pores of the hide; but the result is unrecorded.

Sumached leather.—We have hitherto alluded chiefly to the preparation of the thick hides used for sole-leather; but the thinner and weaker hides, as well as the skins of calves and other animals, are also prepared for use as upper-leathers; in which case it is necessary to reduce their thickness by shaving or paring them down upon the flesh or inner side, before they are subjected to the action of the tanning infusions. Such hides or skins also require, after leaving the hands of the tanner, to be rubbed, softened, and dressed by the currier, in order to bring them to the necessary degree of flexibility and smoothness. Horse-hides, which are comparatively weak and thin, are sometimes dressed on the grain side, under the name of *cordovan* hides, from the circumstance of such leather having been formerly made at Cordova in Spain. Calf-skins supply the kind of leather most generally preferred for the upper part of boots and shoes.

Of the thin skins prepared for ornamental purposes, many are tanned with a substance called *sumach,* prepared from a plant of the same name. The most important kind is that called *Morocco,* which is made from goat-skins. In the routine of operations, the processes of cleansing the skins from fleshy impurities, and removing the hair, &c., present no material variation from those before described. During these processes, the lime employed to assist in the depilation enters the pores of the skin so completely, that it would impede the action of the tanning liquid if allowed to remain. It is therefore removed by immersion in an alkaline solution, which opens the pores in a way resembling the process of raising, described in a previous paragraph. The tanning is then performed by sewing up each skin into the form of a bag, with the grain or hair-side outwards, and nearly filling it with a strong solution of sumach in water. The bag is then fully distended by blowing into it, and the aperture is tied up; after which it is thrown into a large shallow vessel filled with hot water containing a little sumach. The distended bags float in this vessel, and are occasionally moved about with a wooden instrument, until the solution which they contain has thoroughly penetrated their substance. Owing to the thinness of the skins and the heat to which they are exposed, this operation is performed in a few hours. The process is expedited by taking the bags out of the solution and piling them upon a perforated bench or rack at the side of the tub, so that their own weight may force the confined liquid through the pores. When the tanning is completed, the bags are opened to remove the sediment of the sumach; the skins are washed, rubbed on a board, and dried; after which they are ready for dyeing and finishing with a ridged instrument, which imparts to the surface that peculiar grain by which morocco leather is distinguished. An inferior kind of leather, known as imitation morocco, is prepared in a similar manner from sheep-skins.

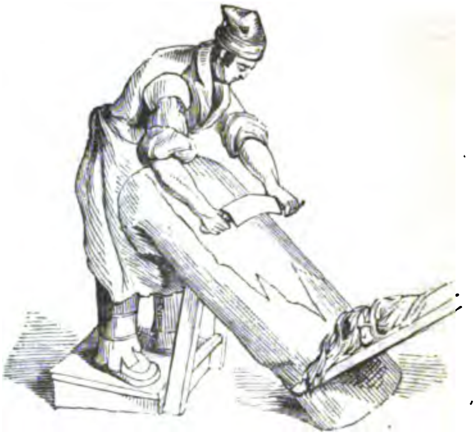


Fig. 2.—Unhairing Goat-skin.

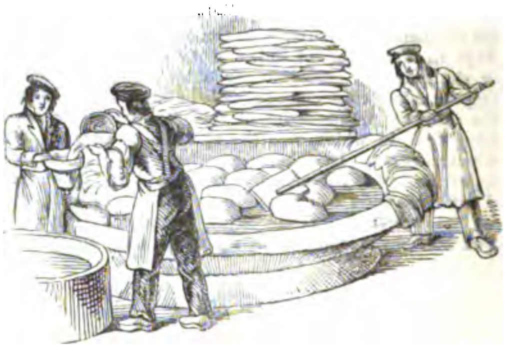


Fig. 3.—Tanning Goatskins with Sumach.

Tawed leather—Tawing is the name applied to the process by which the skins of sheep, lambs, and kids are converted into soft leather by the action of alum. Of this kind of leather gloves are usually made. Skins intended for tawing pass through a series of preliminary operations resembling those by which skins are prepared for tanning; but they are then subjected to a solution of alum and salt, to which, for the superior kinds of leather, flour and yolks of eggs are added, instead of a vegetable astringent solution. Sometimes the skins are put into a kind of barrel with the solution, and then the whole is made to rotate rapidly, by which the skins are quickly penetrated; and in other cases the impregnation is effected in an open tub, the skins being worked in the pasty liquid with the hands, or trampled upon by the naked feet of a man, until the emulsion is thoroughly incorporated with them. They subsequently require a good deal of stretching and rubbing over a kind of blunt-edged knife, and some other finishing operations, to give them the requisite smoothness and suppleness. Many of the gloves sold as kid are really made of lamb-skins, of which considerable numbers are imported from the shores of the Mediterranean. These are brought with the wool on; and, as it would be injured by the action of lime, it is loosened by inducing fermentation or incipient putrefaction in subterranean vaults or cellars; an operation which requires great nicety, since the pelt would be injured by allowing the fermentation to proceed too far. After the wool has been removed, and the skins have been scraped to free them from a slimy substance which exudes from the pores, the pelts are immersed in lime-water for a few days, to remove the grease which yet remains in them. The subsequent operations of removing the lime, tawing, &c., are similar to those required for other skins. In tawing sheep-skins with the wool on, for housings and similar articles, the wool side is carefully folded inwards, to protect it from the tawing liquid or paste, which is then applied to the flesh side only. Alumed leather is made in very large quantities for kid gloves and shoes, real or imitative. The French are skilled in that art. At Annonay, a town about fifty miles from Lyon, the tawing operations are carried on so largely, that 4,000,000 kid-skins are dressed there annually. It has been computed that France and England together consume 6,000,000 eggs yearly, in preparing kid leather. The eggs are kept by the leather dressers in lime-water, to preserve them till wanted for use.

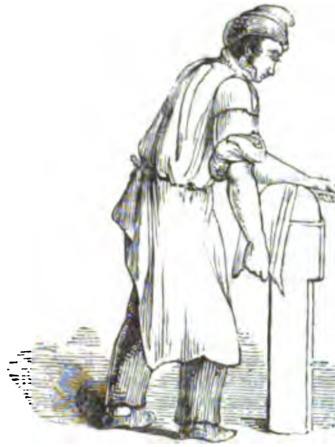


Fig. 4.—Dressing Kid Leather.

Chamois, or *Shamoy leather.*—Another kind of leather is that in which oil or grease is forced into the pores of the skin, to take the place of the animal matter. This kind of leather takes its name from a fine soft leather prepared from the skin of the chamois goat; and the process by which it is made is called *shamoying* or *shammying*. Such leather was formerly very much used as an article of clothing, especially by soldiers; and it is still applied to several useful purposes, for which its peculiar softness and pliability render it valuable. *Wash-leather* may be cited as a common example of this kind of preparation. The skins of deer, goats, sheep, &c. are dressed in this way; and much shamoyed leather is made from the inferior or least regular portion of split skins, in cases where the grain side has been taken off carefully of a uniform thickness for preparation in a different way. In general, when whole skins are shamoyed, the grain surface is removed by scraping or rubbing with pumice-stone. After the usual preparation with lime-water, and subsequent washing in a sour infusion of bran or some similar liquor, to remove the lime and open the pores, the skins are made as dry as possible by wringing or pressing them, and are then exposed to the action of fulling-stocks. These consist of heavy wooden hammers, faced with copper, and set in motion by connection with a revolving shaft. The leather, or rather a roll of the skins which are to be made into leather, is placed in a trough, and beaten by the hammers until it is perfectly dry. Cod-oil is then poured upon the skins, and forced into their pores by the action of the hammers or stocks; the form of the trough being such that the skins gradually turn themselves over and over during the operation, to render the beating uniform. When the oil is thoroughly beaten in, the skins are hung up to dry, after which they are returned to the trough to receive a fresh supply of oil and a repetition of the beating. This is repeated eight or nine times, until two or three gallons of oil have been imbibed by one hundred skins; and when they are sufficiently impregnated with it, they are placed in large tubs, or hung up in close heated chambers, in which they undergo a kind of fermentation, by which the pores are distended, and the action of the oil upon the fibres is completed. Finally, the skins are immersed in a weak solution of potash, which removes whatever excess of oil may have remained in the leather, forming with it a saponaceous mixture. They are then hung up in the open air to dry.

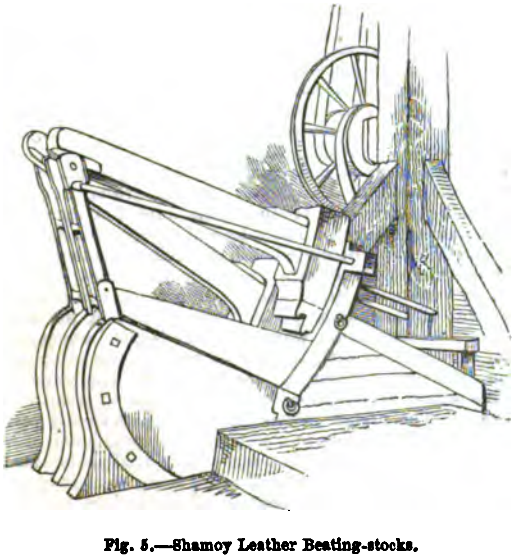


Fig. 5.—Shamoy Leather Beating-stocks.

Currying and Leather Dressing.—Currying is the general name given to the various operations of dressing leather after the tanning is completed, by which the requisite smoothness, lustre, colour, and suppleness are imparted, to adapt it to the various purposes of the shoemaker, the coach and harness maker, the upholsterer, and others. Every kind of tanned leather not intended for soles, or similar coarse purposes, is generally curried before being delivered to the workman who fashions it. The operation commences by moistening the leather with water, and beating it well upon a strong hurdle with a mallet or mace. After this beating, by which the stiffness is destroyed, the leather is laid over an inclined board, and scraped, cleaned, and pared down on the flesh side, by the careful application of various two-handled knives. It is then thrown again into water, and well scoured by rubbing the grain or hair side with pumice-stone, or with a piece of slaty grit. The leather is next rubbed with the *pommel*, a rectangular piece of hard wood, about twelve inches long and five broad; the currier uses several of these instruments, with grooves of various degrees of fineness, and also, for some purposes, pommels of cork which are not grooved at all. In using the pommel, the object of which is to give grain and pliancy to the skins, the leather is first folded with the grain side inwards and rubbed strongly with it; and subsequently it is rubbed with the pommel upon the grain side, without being doubled or folded. The leather is then scraped with tools applied nearly perpendicular to its surface and worked forcibly with both hands, to reduce such parts as may yet be left too thick to a uniform substance. Finally, the leather is dressed with the *round knife*, a singular instrument shaped somewhat like a saucer, with a cutting edge, and with a hole in the centre for introducing the hands of the workman. It is usually from ten to twelve inches in diameter, with the central hole about four or five inches. This tool is applied with its concave side downwards; and with it, while the leather is stretched over a cylindrical wooden beam, the currier dexterously pares off the coarser fleshy parts of the skin. The currier uses occasionally polishers of smooth wood or glass for rubbing the surface of the leather; and, when the leather is intended for the use of the shoemaker, he applies to it some kind of greasy composition called *dubbing* or *stuffing*.

Leather is occasionally dressed "black on the grain," or having the hair or grain instead of the flesh side coloured. The currying operations in such a case are similar to those above described; but the first blacking is applied to the wet skin immediately after scouring, by rubbing it with a solution of copperas. A brush dipped in an alkaline liquor is then passed over the surface, and an iron slicker is used to make the grain come out as fine as possible. It is then stuffed with oil, and, when dry, *seasoned*, or rubbed over with a brush dipped in copperas-water, on the grain, until it is perfectly black; after which it is slicked with a gritstone, to remove any wrinkles and smooth down the coarse grain. The grain is finally raised by repeatedly rubbing over the surface, in different directions, with the pommel or graining-board.

In connection with the dressing of leather, we may briefly notice *Japanned, Russia,* and *Shagreen* leather. Japanned leather of various kinds is used in coach-making, harness-making, and for various other purposes. What is ordinarily termed 'patent leather' is covered with a coat of elastic japan, which gives a surface like polished glass, impermeable to water; and hides prepared in a more perfectly elastic mode of japanning, which will permit folding without cracking the surface, are called 'enamelled leather.' Such leather is usually made black, but may be produced of any required colour. A composition, made of boiled linseed oil, vegetable black, and Russian blue, is rubbed as a thick paste on the surface of the leather by hand; it is dried in a stove heated to 150° or 170° Fahr. This is repeated from three to seven times, according to the excellence of the articles to be produced. Boots and shoes are sometimes made of thin enamelled leather, and they possess the advantage of never requiring blacking, water being sufficient to remove any dirt which impairs their gloss. *Russia* leather called by the Russians themselves *jucten*, is usually dyed red with the aromatic saunders-wood, and is celebrated for being free from mould in damp situations, and not only being proof against insects, but repelling them by its odour, so as to preserve books in the binding of which it is used. The skins are freed from the hair or fleece by steeping them in an ash-lye, then rinsed, fulled, and fermented in a proper steep, after having been washed in hot-water, for a week or more, to *raise* or open their pores. They are then cleaned, by working them upon the horse, on both sides. They are next soaked for forty-eight hours in a bath composed of water mixed with a paste of rye-flour. The skins, when taken out of the bath, are left in tubs for fifteen days, and then washed. Being thus prepared for the action of the astringent or tanning juices, they are immersed in a boiler containing a hot decoction of willow bark, in which they are handled and pressed for half an hour. This manipulation is repeated twice a day for a week, after which the tanning infusion is renewed, and the process is repeated on the same skins for another week. The skins are then exposed to the air to dry, dyed, and curried with the empyreumatic oil of the bark of the birch-tree. *Shagreen* is a peculiar kind of leather, or rather of prepared skin, formerly much used for the covers of watch-cases, mathematical-instrument cases, &c. The skin, after being soaked in water and scraped to remove the hair, is stretched upon a frame, and the grain-side is strewed with the hard round seeds of the *alabuta*, or goose-foot. A felt being laid over these, they are trodden deeply into the soft yielding skin; after which the frames are so placed in the shade as to allow the skins to dry slowly, when the seeds may be shaken out without violence, leaving the skin in a hard horny state, covered with deep indentations. The surface is then rasped or rubbed down with iron tools, nearly to the bottom of the holes or indentations, the skin during this operation being laid upon a block covered with wool. The skins are next softened, first with water, and then with a warm alkaline ley, and are heaped, while warm and wet, upon each other; and by this softening the depressed parts of the skin rise to their former elevation, forming prominent points wherever depressions had been made by the seeds. The skins are then salted and dyed, after which they are finished with oil or suet.

Great difficulties present themselves in the way of any application of machinery to the dressing of leather, in consequence of the varying hardness, thickness, and texture, not only of different skins, but of different parts of the same skin; yet the great amount of time and manual labour involved in the polishing and graining of morocco and other ornamental leathers has led to some ingenious contrivances for this purpose. Hebert contrived a machine consisting essentially of a stiff circular frame or wheel, eight feet in diameter, revolving horizontally upon a vertical axis, and carrying, on the underside of its periphery, a series of circular polishers or grainers; but it was not brought much into use. Leather-splitting machines, by which even very thin skins may be divided into two thicknesses, each capable of being dressed as a perfect skin, have called forth much ingenuity of contrivance. Before such machines were introduced, the reduction of thickness necessary to bring many of the finer kinds of leather to the requisite tenuity was effected solely, as it still is partially, by paring or shaving the flesh side with a knife worked by hand, an operation occupying much time, and requiring great nicety to prevent cutting through the skin. The part shaved off, also, being necessarily in small pieces, was only available for the making of glue. By the use of a machine, however, the best portion of the leather, that with the grain side, is out of a much more uniform thickness, and with less risk of injury; the removed portion is taken off in a more useful form; and the whole operation is conducted more rapidly. One such machine is so accurately constructed, that it has been made to split sheep-skins into *three* equal parts; one of which, that on the grain-side, might be used as leather, the middle portion converted into parchment, and the slice on the flesh side, being unequal in thickness, and therefore unfit for any better use, being used for glue-making. In this machine, the skin is drawn between two revolving rollers, and is presented, as it emerges from their grasp, to the edge of a long and very sharp knife, which is kept continually moving a little backwards and forwards with great velocity. As a skin of unequal thickness could not be grasped in the proper manner between two perfectly true and rigid rollers, the upper roller, instead of being solid, is composed of a number of circular discs or rings of metal, about half an inch thick, slipped on to an axis; by this contrivance the upper roller is enabled to adapt its surface to that of the skin, which is everywhere pressed with an equal force, due to the weight of the discs of which the upper roller is composed. This machine will split a sheep-skin of the ordinary size in about two minutes, during which time the knife makes from two to three thousand vibratory motions to and fro.

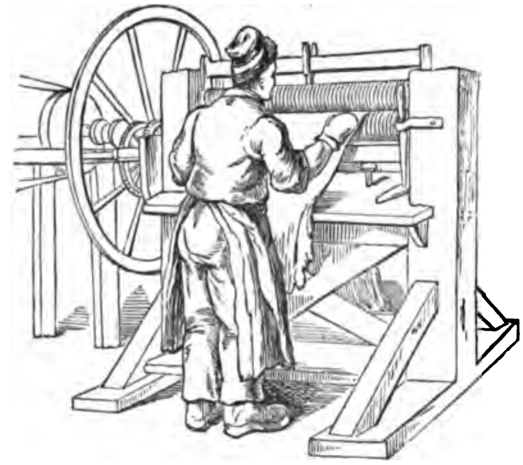


Fig. 6.—Leather Splitting Machine.

Various kinds of *imitative* leather have engaged the ingenuity of manufacturers. One, patented many years ago, consists of an elastic coating or varnish of glue-size, boiled linseed-oil, lampblack, white lead, and pipeclay, varying in proportions according to the degree of elasticity required, and spread upon cotton, linen, woollen cloth, or felt. Hancock's substitute for leather consists of a felted fabric of flax, cotton, or other material, covered with several coats of liquid caoutchouc. Gunby's substitute is chiefly intended for the manufacture of patten-ties, but is suitable also for covering coach-tops, and for some other purposes. Crockett's *leather cloth*, and other kinds made in the United States, are very useful products. A clever imitation of Morocco leather is produced by applying a layer of India-rubber or gutta-percha to a surface of cotton-cloth; the surface is corrugated, stained, and varnished; it is elastic and durable, costs only one-third of Morocco leather, and cuts to advantage through being made in great widths. Messrs. Spill & Co., of Stepney, are now manufacturing a remarkable substance under the name of *vegetable leather*. It resembles leather-cloth in being an application of caoutchouc to a woven ground-work or back; but naphtha also takes part in its preparation, and it has other peculiarities. It is producible in pieces 50 yards long by 1¼ yards wide, thereby being rendered applicable to many purposes for which hides or skins of real leather would be too small. Its thickness may be varied to any degree by varying the number of cemented layers. Many of the good qualities of leather are presented by it, at one-third the cost. The vegetable leather is used in making carriage and horse aprons, soldiers' belts, buckets, harness, book covers, and other articles.

Various modes of decorating leather are adopted, of which three or four may be briefly noticed. East's *embossed* leather is prepared with the flesh side outwards, instead of the grain side, as in ordinary leather. Sumached sheep-skin is found to be best; it requires many processes, but when completed, the leather presents a very smooth surface, which will receive an embossing by means of heated engraved rollers. Pegg's *corrugated* leather consists of two thin pieces of leather cemented to strips of vulcanised caoutchouc placed between them, then passed between heated grooved or fluted rollers, and finally rendered soft and pliable by soaking in warm water. Wood's *metalled* leather has a metallic ornamental device applied, either by printing with a paste or ink formed by mixing metal powder with starch, bees'-wax, and water, or by printing with a glaire or varnish, and sprinkling with metal powder while the surface is wet. In either case the leather is dried by steam-heated cylinders, and the brilliancy of the metal brought out by passing the leather between calendering-rollers. Leake's *relievo* leather is produced by pressing the leather while moist into moulds. Some of the specimens almost equal wood carving or plaster casts in the fineness of detail of the flowers, foliage, fruits, &c., imitated. Relievo medallions have been produced with a relief of more than two inches, and much undercut. The saloon of the Queen's state steamer 'Victoria and Albert' is decorated with this relievo leather. We may here state that the stamped leather, formerly much used for hangings, was made by moistening the leather, laying it on or in a mould, and pressing it into all the minute parts of the devices of the mould by means of small wooden tools; when dry, the leather was coated with silver-leaf, or varnished with lacquer to produce the colour of gold. After this, the proper colouring was laid on by hand, and certain parts of the leather were stamped by a hand-punch to produce various small devices. The French revived this art about twenty years ago, employing hydraulic pressure in stamping. The production of leather ornaments has recently been made a sort of industrial pastime for ladies.

Leather Trade.—The leather manufacture is one of great importance in this kingdom, giving employment in all its various branches to a very great number of persons. The Census of 1851 showed that, taking into the account tanners, curriers, leather dressers, shoemakers, glove-makers, harness-makers, saddlers, and other branches of the leather manufacture, there were 350,000 persons professedly employed in those trades, besides those who were indirectly supported thereby. Our tanners, besides using up nearly all our own oak bark, require annually from abroad 250,000 cwts. of oak bark, 120,000 cwts. of other bark, and 750,000 cwts. of terra japonica, sumach, cutch, valonia, and other substances containing tannic acid. It has been computed that the manufactured articles are worth from three to four times as much as the leather itself, and that the total annual value must be at least

20,000,000*l.* Most of the leather made in this kingdom, and of the articles formed with it, are used at home. The importations of hides, skins, and articles of leather in 1859 were as follow :—

Hides, untanned, dry	250,296 cwt.
„ „ wet	611,391 „
„ tanned, tawed, or dressed	4,962,192 lbs.
Leather boots and shoes	713,274 pairs
Leather gloves	4,590,261 „

The actual number of hides and skins imported for conversion into leather is not stated in the official returns; but persons in the trade estimated them a few years ago as follows :—

Hides and kips	2,550,000
Calf skins	270,000
Horse hides	230,000
Seal skins	590,000
Goat skins	460,000
Sheep skins	210,000
Lamb skins	1,430,000
Kid skins	50,000
Deer skins	90,000

The exports of leather, except manufactured articles, are very small: they amounted only to 42,136 cwt. in 1859. The leather goods (excluding saddlery) exported were 6,669,210 lbs., with a declared value of 1,359,189*l.*, or about 4*s.* per lb. on an average. The saddlery and harness were estimated only by value, 289,631*l.* The Australian colonies are the great purchasers of all these articles.

LEAVEN. [BREAD.]

LECANORIC ACID. [LICHENS, COLOURING MATTERS OF.]

LECANORIN. [LICHENS, COLOURING MATTERS OF.]

LEDITANNIC ACID. [TANNIC ACID.]

LEECHES, MEDICAL USE OF. Of the species described in the article ANNELIDA, in NAT. HIST. DIV., it is intended to treat here only of those of the genus *Sanguisuga* (Savigny), or *Jatrobdella* (Blainville), as they only can be employed for medical purposes. The same reason induces us to confine our attention to the species *S. officinalis* (Savigny) and *S. medicinalis* (Savigny).

Though the *S. obscura* and *S. interrupta* might be employed to withdraw blood, yet the *S. officinalis* and *S. medicinalis* are chiefly so used. The former is also termed the Hungarian or green leech (*Hirudo provincialis*, of Carena; *S. meridionalis*, of Risco), while the latter is termed the German, or brown, or gray leech, also the true English or specked leech. The one species abounds in the south of Europe, while the other is a native of the north. The *S. medicinalis* is now rare in England, owing to the draining of so many of the ponds and bogs in which it formerly abounded. The same is nearly the case in France, which used to be supplied chiefly from the district of La Brenne, but now from the frontiers of Russia and Turkey. England derives the immense number required mostly from Sweden, Poland, and Hungary.

The genus *Sanguisuga* is characterised by having the body elongated, the back convex, the belly flat, and the oral and caudal extremities narrowed, before they spread out into discs or suckers. The body consists of from ninety to one hundred or more soft rings, which do not increase in number, but only in size, with the age of the animal, which requires about eight years to come to maturity; and if it escape being devoured by others which prey upon it, it may attain twenty years. The anterior or oral extremity is rather narrower than the caudal: it is provided with ten blackish points or eyes, and a triradiate (not triangular) mouth, furnished with three cartilaginous jaws, each armed with numerous cutting-teeth. The anus is very small, situate on the dorsal surface of the last ring.

The *S. officinalis* has a green body or light blackish-green, the back marked with six longitudinal bands of an iron colour, spotted with black spots at their middle portion and edge. The belly is of a yellowish-green *without spots*, but broadly bordered with black. The segments of the body are very smooth. It is large, often seven inches long. It lives in pools and rivers. There are three varieties.

S. medicinalis has the body of a deep green, its back marked with six longitudinal bands of an iron colour, pretty clear, spotted with black points, generally triangular. The belly is greenish, *spotted*, and broadly bordered with black, and the segments of the body rough from granular eminences. It inhabits ponds and small lakes.

Of the anatomy of the leech it is not necessary to say much. The skin consists of two layers, the external or epidermis, and the internal or corium. The first is transparent, resembling a serous membrane; this is thrown off from the body every four or five days. The corium consists of condensed cellular tissue. It displays the divisions into rings, and in it resides the colouring matter of the leech.

The alimentary system consists of the mouth, the stomach, salivary glands, liver, and anus. The mouth has a triradiate figure, formed of three equidistant lines, meeting in a centre, about the middle of the oral disc. Inside are three sublenticular jaws or piercers, white, and of a cartilaginous appearance. On the free, curved, sharp margin of each jaw there are about sixty small fine-pointed teeth. The alimentary canal consists of an œsophagus, a long stomach, with cæcal sacs, and an intestine. The œsophagus is a muscular tube, and commences between the inner angle of the three jaws by a roundish opening: it dilates as it approaches the stomach, but at its termination it contracts into a circular aperture: the whole length does not exceed a quarter of an inch. The stomach occupies two-thirds of the length of the animal, and is formed of eleven compartments or cells. Each of these divisions, that is, from the second to the eleventh, gives off on each side a sac, of which those of the last cell are much the largest. The intestine is about an inch in length; at the upper orifice is a valve, and at its lower a sphincter. These organs can contain nearly half an ounce of blood; so that there is nothing remarkable in the statement that leeches have been known to exist three years in water, without any other nourishment than they could obtain from it; for the blood is received into cells quite distinct, in the first eight of which it remains for months, without undergoing any change either in colour or fluidity: over these cells the animal has a perfect control, merely allowing so much nutriment to pass into the alimentary canal as is necessary to preserve its existence. This accounts for the reluctance of the animal, after being used to abstract blood, to repeat the operation; it not only being gorged at the time, but provided with nutriment sufficient to serve it during almost a sixth portion of its life. In its native abode the true medicinal leech does not seem to take any solid aliment, but subsists on the fluids of fish, frogs, &c.

Leeches are oviparous. The ova remain in the uterus for some time, where they become invested first with a serous membrane, and then with a glutinous fluid, which remains attached to them after their expulsion, and serves as a protecting covering after they are deposited in the clay and holes of the sides of the ponds. The leeches generally deposit the *cocoons* from May to the end of September. It would seem that these animals do not multiply in great abundance unless they have tasted blood, particularly that of cows. On this account the leech-dealers of Bretagne drive horses and cows into the ponds to such an extent that the cattle of the district are in general wretched-looking, and the leech-gatherers not much better.

About five years are required before the leech attains a state of maturity; while very young they are quite unfit for medical purposes. They are caught in various ways, by the hand, or by a person wading in the shallow waters during the spring of the year, when they adhere to his naked legs; but in summer, as they have retired to deeper waters, a raft is constructed of twigs and rushes, by which a few are entangled. Baits are deposited, generally pieces of decayed animal matter or liver, to which the leeches resort, and are then caught; but this last method is thought to injure the health of the animal. Many sicken and die on the journey, especially during warm weather. They are conveyed either in bags or small barrels with a canvas cover.

Leeches are subject to many diseases, several of which are epidemic, and spread in the troughs with great rapidity. On the first appearance of illness the sick should be immediately separated from the healthy. Care should be at all times taken that different species of leeches be not associated in the same trough, for they prey upon each other. The *Hæmopsis vorax*, and *H. nigra* (*Pseudobdella*, Blainv.), or common black leech, devour greedily the *S. medicinalis* or *S. vulgaris*, though they cannot penetrate the skin of vertebrated animals. The horse-leech, *Hæmopsis sanguisodea*, Sav. (the *Hirudo sanguisuga*, Linn.; *Hypobdella*, Blainv.), is not certainly without the power of penetrating the human skin, though the black leech, often confounded with it, has no such power, from want of teeth.

A leech may be known to be in good health if it be active in the water and plump when taken out. In Prussia leeches are divided into three classes, according to their weight: the first not exceeding 30 grains; the second weighing between 30 and 60 grains; the third from 60 to 90. Leeches above 90 grains are not to be used, unless specially ordered. In each prescription the physician is required to state what description of leech he intends should be used. In the case of children such regulations are highly proper, as an excess of blood abstracted may easily produce serious and often fatal consequences. Leeches vary in the quantity they can abstract, from one drachm to half an ounce: from one to two drachms is the average. The quantity is often doubled by the expedients resorted to after the leech has been removed, either dry or wet clothes being applied, or in many cases cupping-glasses, but cataplasms of linseed-meal are most beneficial where they can be applied.

One gray or German leech is deemed equivalent to two green or Hungarian leeches. The cases requiring or justifying the application of leeches are stated under the respective diseases, and need not be repeated here. It is of more importance to indicate the proper mode of applying them. The leech, though not so accurate an index of the weather as is commonly believed, is yet sensible of atmospheric changes, and in some (probably peculiarly electric) conditions of the atmosphere cannot be induced to bite. In such cases time ought not to be wasted, nor the patient exposed injuriously or kept in a fatiguing position, but some other mode of blood-letting should be had recourse to. Moreover, if the leech be sickly, it can rarely be made to bite. Certain states of the patient also hinder or indispose them to bite. Where the skin is very thick they cannot puncture it; or if the person has been using sulphur, the exhalation of the sulphuretted hydrogen is disagreeable to them; even the fumes of tobacco, vinegar, &c., will prevent them biting; also if grease, salt, or vinegar be on the spot to which they are applied, they refuse to attach themselves to it. The existence of hairs on the spot seem to hinder them from biting, and also from forming a vacuum to suck up the fluid, on which account they should be carefully shaved off. The leeches should be taken out of the water, and allowed to creep for some time over a dry warm cloth; in the meanwhile, the part where it is intended to apply them should be washed with *plain* (not perfumed) soap and water, then with water alone, afterwards with milk or porter. It is difficult to make them fix themselves on the particular spot wished; but a leech-glass will generally effect this, and is preferable to holding the leech in the hand. When they still refuse to bite, slightly puncturing the part with any sharp instrument, so as to cause a little blood to ooze out, is a useful expedient; or if we pluck a feather from the wing of any bird, and, cutting off the end, allow the liquid contained in it to be dropped on the spot, the leech will bite readily.

When the leech has dropped off, it should be seized by the tail or caudal end, and striped between the finger and thumb, so as to cause it to disgorge most of the blood. It is proper to allow it to retain a third of the blood. This is preferable to applying salt or vinegar to the mouth. It should then be placed in many successive fresh waters, and it may perhaps survive, and after many months be again fit for use. In winter, it should be put at first into tepid or luke-warm water; for though *cold-blooded* itself, its body has been filled with blood of a temperature of nearly, or perhaps above, 100° Fahr.

When no expedient is had recourse to, in order to maintain the flow of blood, it generally stops spontaneously; but in some cases it continues much longer than is proper. Where the blood is either deficient in coagulating power, as happens in many weak persons, or when it is in a very alkalescent state, and the albumen in too dilute a condition, or owing to the very vascular state of the skin of children, the hæmorrhage is often troublesome, and in the case of children, who do not bear well the loss of a large quantity of blood, sometimes fatal. The object of any remedial means is to form a coagulum, or plug, at the mouth of the bleeding vessels. A weak solution of creasote applied to the part will generally effect this, or felt scraped from a hat, or gum in powder, or flour, or the dust of the puff-ball (lycoperdon or bovista), or the application of a compress and bandage, tying a ligature, or touching the wounds with lunar caustic. The patient should at the same time drink a saturated solution of alum, or take dilute sulphuric acid out of very cold water.

The increasing scarcity of leeches renders their preservation and propagation objects of primary importance. The death of a vast number of leeches is occasioned by errors in the method of keeping them. Though aquatic animals, it is not enough that they be supplied with water. They breathe by their entire surface, and are accustomed to change their skin every four or five days. Their body is covered, like that of all animals and plants which inhabit the water, by a slimy or mucilaginous fluid, which not only enables them to glide through the water, but keeps an aërial stratum in close contact with their respiring surface. When present in a limited degree, this mucous secretion is highly serviceable to them; in excess, it is destructive. It is impossible for them to diminish it when it has accumulated, or to denude themselves entirely of their old skin, in water only. They must have some resisting body to creep over or through in order to accomplish this object. Some leech-dealers keep clay at the bottom of the troughs, and though this is useful as a material in which the leeches can burrow in warm weather (by which they are always more injured than by cold, if not intense; and it is their habit to retreat to the deepest waters of their native rivers or ponds in summer), it is inadequate to the end. The best method seems the following recommended by Fee:—

Into a marble or stone trough a layer of seven inches of a mixture of moss, turf, and charcoal of wood is to be put, and some small pebbles placed above it; at one extremity of the trough, and midway between the bottom and the top, place a thin plate of marble pierced with numerous small holes, upon which there should rest a stratum of moss or portions of the equisetum palustre, or horse-tail, firmly compressed by a stratum of pebbles. The trough to be replenished with water only so high that the moss and pebbles should be but slightly moistened. A cloth is to be kept over the mouth of the trough. This is imitating as near as possible their natural condition, and the charcoal not only aids in keeping the water sweet, but appears to prevent the leeches being attacked by parasitic animals, to which they are very liable. The water should be changed about once a week, and more frequently in warm weather.

Leeches have not been observed to propagate when kept in small bodies of water, but in large reservoirs, having a body of turf and rushes, and the sides well furnished with clay, in which to deposit the cocoons, Dr. Noble of Versailles has succeeded in procuring young ones. It has also been ascertained in France that leeches which have been used, if restored to their natural haunts, propagate abundantly, and also become capable of being again applied after eight or twelve months' stay in these congenial quarters.

The great extent to which the trade in leeches is carried on renders attention to this subject of paramount importance. Four only of the principal dealers in London used to import 7,200,000 annually, and in Paris 3,000,000 are used. But in England the consumption of leeches is now (1860) very greatly diminished.

Leeches have sometimes been swallowed; and in Syria and other places a small leech is sometimes drank with the waters of the pools, and by adhering to the throat causes great suffering. Salt or vinegar is the best means of dislodging them. Besides these Syrian leeches, there is in Ceylon, the lower range of the Himalayan Hills, Batavia, and other islands a land-leech (*Hæmadipsa Ceylonica*, Bosc.) which is of a formidable nature, not from its size, "for they are only about an inch in length, and as fine as a common knitting-needle; but capable of distension till they equal a quill in thickness, and attain a length of nearly two inches. Their structure is so flexible that they can insinuate themselves through the meshes of the finest stocking, not only seizing on the feet and ankles, but ascending to the back and throat, and fastening on the tenderest parts of the body. The coffee planters, who live among these pests, are obliged, in order to exclude them, to envelope their legs in 'leech-gaiters' made of closely woven cloth. The natives smear their bodies with oil, tobacco ashes, or lemon-juice; the latter not only serving to stop the flow of blood, but to expedite the healing of the wounds. These creatures are gregarious, and make their attacks in concert, with such well directed tactics, that it is difficult to elude them." 'Ceylon,' by Sir J. E. Tennent, vol. i. p. 301 of 2nd edition. In the same island, a cattle-leech (*Hæmopsis paludum*) is most formidable to cattle which go to drink in the ponds frequented by them. They are very insidious, and their bite at first gives little pain, but the consequences are often fatal. (Ibid p. 306.) These are probably the same as are mentioned by Pliny ('Hist. Natur.' viii. 10.) as distressing the elephants.

(Johnson *On the Medicinal Leech;* Brandt and Ratzeburg, *Getreue Darstellung der Thiere;* and Mr. Pereira's *Mat. Med.*)

LEET is the precinct or district within the cognisance or subject to the jurisdiction of a court-leet. Sometimes the term is used to denote the court itself, the full style of which is "the court-leet and view of frank-pledge." The court-leet is also called a law-day, as being the ordinary tribunal.

I.—*Origin of the Court-leet.*

One of the least improbable derivations of the word "leet" seems to be that which deduces lath and leet from the Anglo-Saxon "lathian," or "gelathian," to assemble; both lath and leet indicating, under different modifications, a district within which the free male resiants (residents) or indwellers assembled at stated times, as well for preparation for military defence as for purposes of police and criminal jurisdiction. Of the first of these objects scarcely any trace exists in the modern leet. The title of the court as a "view of frank-pledge," points to its former importance under the extensive system of police introduced or perfected by King Alfred, which required that all freemen above twelve years of age should be received into a decennary, or tithing, called in Yorkshire and other parts of the north, "ten-mentale" (number, tale, or *tally* of ten men), and forming a society of not less than ten friborgs or freeborrows (freemen), each of whom was to be *borhoe*—that is, pledge or security for the good conduct of the others. So the German "bürge," pledge or surety (fidejussor), appears to be derived from the verb "borgen," to give or take on credit. In this sense, in the 'Franklin's Tale,' Chaucer has, "Have here my faith to borwe;" and in the 'Squire's Tale,' "St. John to borwe."

In the ballad of 'The Rising in the North,' preserved in Percy's 'Reliques of Ancient Poetry,' Lady Northumberland, proposing to her husband to place herself in the hands of Queen Elizabeth, as a surety or hostage for his submission, says, "Thy faithful borrow I will be."

When a party was accused of a crime, his tithing was to produce him within 31 days, or pay the legal mulct for the offence, unless they proved on oath that no others of the tithing were implicated in the crime, and engaged to produce him as soon as he could be found. For great crimes the offender was expelled from the tithing, upon which he became an outlaw.

The duty of inspecting a decennary or tithing was called a view of frank-pledge, the freeborrows having received from their Norman conquerors the designation well known in Normandy of frank-pledges. The principal or eldest of these freeborrows, and as such the person first sworn, who was denominated the tithing-man, sometimes the headborough or chief pledge, sometimes the borsholder or borsalder (borhes-alder, or senior or ruler of the pledges), and sometimes the reeve, was in an especial manner responsible for the good conduct of each of his co-pledges, and appears to have had an authority analogous to that still exercised by the constable, an officer elected by the resiants for the preservation of the peace within the district constituting the leet, tithing, or constablewick. This officer is in many places called the headborough, which designation, as well as those of borsholder and tithing-man, is frequently used by the legislature as synonymous with that of constable. It is probable that all the frank-pledges were numbered according to rank or seniority, as in places where more than two constables are required, the third officer is called the thirdborough. Blackstone, misled by the sound, supposes headborough to be the chief person or head of a town or borough. This derivation will remind the readers of 'Hudibras' of the "wooden bastile" (stocks), which

> "None are able to break thorough,
> Until they're freed by *head of borough*."

The Holkham manuscript of the Anglo-Saxon customary law says: "A tithing (there called decimatio) contains, according to local usage, ten, seventy, or eighty men, who are all bound (debent) to be pledges (fidejussores) for each other. So that if any of them be accused (calumpniam patitur), the rest must produce him in court; and if he deny the offence, he is to have lawful purgation by the tithing (that is, by their swearing to their belief of his innocence). A tithing is in some places called a *ward*, as forming one society, subject to observation or inspection within a town or hundred. In some places it is called "borch;" that is, pledges for the reasons above stated. In others it is called tithing (in the original, decimatio), because it ought to contain ten persons at the least."

The assizes of Clarendon directed "that all the customs of frank-pledge should be observed; that a person receiving men into his house or land, or within his jurisdiction (soke), who were not in frank-pledge, should be answerable for their appearance, and that no franchise or liberty [LIBERTY] should exclude the sheriff from entering for the purpose of seeing that views of frank-pledge were duly held."

Leets are either public or private. The public leet is an assembly held in each of the larger divisions of a county, called a hundred, at which all freemen who are resiants within the hundred are bound to attend in person or by their representatives. These representatives were the reeves or chiefs of their respective tithings, whether designated by that or by any of the other appellations, each of whom was accompanied by four good and lawful men of, and elected by, the tithing which deputed them. This public court-leet was held formerly by the royal governor of the county, the ealdorman of the Saxons, the earl of the Danes, the comes or count of the Normans. This great functionary was accompanied by the shire-reeve, an officer elected by the county to collect the king's rents and the other branches of the royal revenue, who, in the absence of the ealdorman, presided in the court, and governed the county as his deputy, whence he is called by the Normans a vice-comes or vicount, though in English he retained the name of shire-reeve or sheriff, the designation connected with his original and more humble duties. This public court, which was originally called the folkmote, being held successively in each hundred in the course of a circuit performed by the sheriff, acquired the name of the sheriff's *tourn*, by which name, though itself a court-leet, it is now distinguished from inferior private leets. The latter courts appear to have been created at a very early period by grants from the crown obtained by the owners of extensive domains (which afterwards became manors) [MANOR], and most frequently by religious houses, for the purpose of relieving their tenants and those who resided upon their lands from the obligation of attending the tourn or leet of the hundred, by providing a domestic tribunal, before which the resiants might take the oath of allegiance and the frank-pledges might be inspected, without the trouble of attending the tourn, and to which as an apparently necessary consequence, the criminal jurisdiction of the precinct or district was immediately transferred. In these private leets the grantee, called the lord of the leet, performed the duties which, in the public leet or tourn, after the ealdorman or earl had permanently absented himself, fell upon the sheriff. Their duties he might perform either personally or by his steward; and as a compensation for this, and his trouble in obtaining the franchise, it appears to have been the practice for the great land-owner who by his money and his influence had procured the grant of a private leet to claim from resiants a certain small annual payment by the name of certum letæ. The tenants within the precincts of a private leet, whether in boroughs, towns, or manors, formed a body politic wholly independent of the tourn or leet of the hundred; whilst such upland, or unprivileged, towns as had not been formed into or included within any private leet, still appeared, each by its tithing-man or reeve and four men of the tithing, and formed part of the body politic of the hundred. Each of these communities appears to have exercised most of those rights which it has latterly been supposed could not exist without incorporation. In many cities and boroughs the ancient authority of the court-leet was in later times superseded by charter of incorporation, in some of which the important right of popular election of magistrates was preserved entire; whilst in the great majority of cases the right, though continued in name, was fettered, if not rendered altogether nugatory, by restrictions of various characters and degrees, which are still to be seen in boroughs not regulated by the Municipal Corporation Act. In other respects the course prescribed by these charters was adapted to the changes which had taken place in the habits of the people since the institution of the court-leet. Many of the functions of the magistrates in the new incorporations were borrowed from the then comparatively recent institution of justices of the peace.

II.—*Constitution of the Court-leet.*

This court is a court of record, having jurisdiction of such crimes as subject the offenders to punishment at common law. The exclusive exercise of criminal jurisdiction being inherent in the kingly office, all criminal matters are denominated pleas of the crown, and the courts in which such pleas are held are the king's courts, although granted to a subject; for such grant operates merely as an authority to the grantee to preside judicially by himself or his steward, and to take the profits of the court to his own use. The authority so exercised under the king's grant is called a lordship, and the grantee is said to be the lord of the leet. It may be claimed either by a modern grant or by prescription, that is, long established user, from which an ancient grant is presumed. The grantee, whether claiming under a grant still extant or by prescription, is commonly the lord of a manor, and the leet is usually coextensive either with the actual limits of the manor, or with its boundary at some former period. There may however be several leets in one manor, and a leet may be appendant to a town, or to a single house. It is not necessary that the lord of the leet should have a manor, or indeed that he should have any interest in the land or houses over which the leet jurisdiction extends. As the leet was originally granted for the more convenient administration of justice, the lord may be required by writ of mandamus to hold the court. Upon non-user of a leet, the grant is liable to be seised into the hands of the crown, either absolutely as for a forfeiture, or *quousque*, that is until the defect be amended; the same consequence ensues upon neglect to appoint an able steward and other necessary officers, or to provide instruments of punishment.

Private leets are commonly held, as public leets *must* be, twice in the year, within a month after Easter, and within a month after Michaelmas, and even the former cannot, unless warranted by ancient usage, be held at any other time except by adjournment. The court appears to have been formerly held in the open air. It should be held at its accustomed place, though, if sufficient notice be given, it may be held anywhere within the precinct. All persons above the age of twelve years and under sixty (except peers and clergymen, who are exempted by statute, and women and aliens), resiant within the precinct for a year and a day, whether masters or servants, owe suit to (that is, personal attendance at) this court, and here they ought to take the oath of allegiance. The suit to the court-leet is said to be real (that is, regal or due to the king), because every one bound to do suit to such court as a resiant, is also bound to take the oath of allegiance unless he has taken it before. But where a non-resiant is bound by tenure to join with the resiants in making presentments at the court-leet, the duty is not suit-real, for he shall not be sworn to his allegiance, &c., at this leet. It is merely suit-service, that is, a suit forming one of the services due from the tenant to his lord in respect of the tenure. A man who has a house and family in two leets, so as in law to be conversant or commorant in both, must do his suit to the leet where his person is commorant, namely, where his bed lies, but if he occasionally reside in both, he is bound to do suit to each.

III.—*Jurisdiction of the Court-leet.*

The Anglo-Saxon Hundred Court appears to have had jurisdiction in all causes, civil, criminal, and ecclesiastical; and also to have had the cognisance and oversight of all the communities of frank-pledges within the hundred, the members of these communities being bound for that purpose to attend at the Hundred Court by themselves or their elected representatives. The jurisdiction of the Hundred Court in ecclesiastical matters was taken away by an ordinance of William the Conqueror, forbidding the attendance of the bishop.

It was the province of the court-leet, as well the public leet of the hundred, as the private leet, to repress all offences against the public peace, and to enforce the removal of all nuisances affecting the public convenience.

The leet jury possess a legislative authority in establishing by-laws. By-laws made in a court-leet and embodied in the presentments of the jury in respect of matters properly cognisable in the leet, are binding upon resiants, but not upon strangers. [BY-LAW.] A by-law imposing a penalty of 5*l.* per month for taking or placing an inmate without giving security to the overseers against any charge upon the parish was said by Lord Hale to be usual and valid. The leet jury elect their own chief magistrates, the reeve or constable, &c., of the private leet, and, as it would seem, the high constable (sometimes called the alderman) of the hundred.

Before the Norman conquest, and probably for some time after, this court of the leet was, if not the sole, at least the ordinary tribunal for the administration of criminal justice in the kingdom. Until the reign of Henry I., when, with respect to certain heinous offences, the punishment of death was substituted for pecuniary compositions, no crime appears to have been punished by death except that called in the laws of that prince "Openthifte," a theft where the offender was taken with the *mainour*, that is, with the thing stolen upon him. [ROBBERY.] Of this crime, as requiring no trial or presentment, the leet had no cognisance. Other offences, of however serious a nature, subjected the party to a mulct, or pecuniary fine, the amount of which was in many cases determinate and fixed.

Offences to be merely inquired of in leets are arson, burglary, escape, larceny, manslaughter, murder, rape, rescue, sacrilege, and treason, and every offence which was felony at common law. These offences being presented by the leet jury as indictors, and the indictment being certified to the justices of gaol delivery, the indictees may be arraigned; but they cannot be arraigned upon the mere production of the court-roll containing the presentments. Formerly all offences inquirable in leets were also punishable there by amercement; but the power of adjudicating finally upon crimes in courts leet, whether public or private, is now limited to such minor offences as are still left under the old system of pecuniary compensation. No matters are cognisable in the leet unless they have arisen or have had continuance since the last preceding court.

An amercement is a pecuniary punishment which follows of course upon every presentment of a default or of any offence committed out of court by private persons. Amercements are to be mitigated in open court by affeerers (afferratores, from afferrare or afforare, *afferer*, to tax, or fix a price, hence the term afferage, used in the old French law to denote the judicial fixing of a price upon property to be sold). The affeerers by their oaths affirm the reasonableness of the sum at which they have assessed the amercement. This course is sanctioned and confirmed by Magna Charta, which directs that amercements shall be assessed by the peers of the offender, that is, the pares curiæ, or suitors of the same court. [JURY.] The amercements, being affeered, are estreated (extracted) from the court-roll by the steward, and levied by the bailiff under a special warrant from the lord or steward for that purpose, by distress and sale of the goods of the party, which may be taken at any place within the precinct, even in the street: or the lord may maintain an action of debt for such amercement. For a nuisance, the jury may amerce the offender, and at the same time order that he be distrained to amend it.

The steward of a leet is a judge of record, and may take recognisances of the peace; and he may impose a fine for a contempt or other offence committed in court, as where a party obstructs the jury in the execution of their duties, or by public officers in the discharge of their duties out of court. The amount of the fine is at once fixed by the steward, and therefore, though sometimes loosely called an amercement, it is not to be affeered. When a suitor present in court refuses to be sworn, it is a contempt for which a reasonable fine may be imposed; so if the jury, or any of them, refuse to make a presentment, or depart without making it, or make it before all are agreed. In all matters within the cognisance of a court-leet the lord or steward has the same power as the judges in the superior courts. He has indeed no power to award imprisonment as a punishment for offences presented in the leet, such offences being the subject of amercement only: but he may imprison persons indicted or accused of felony before him, and persons guilty of a contempt in face of the court.

Of common right the constable is to be chosen by the jury in the leet; and if the party chosen be present, he ought to take the oath in the leet; if absent, before justices of the peace. If he refuse to accept the office, or to be sworn, the steward may fine him. If the party chosen be absent and refuses, the jury may present his refusal at the next court, and then he is amerced. But a person chosen constable in his absence ought to have notice of his election. A mandamus lies to the steward of a leet to swear in a constable chosen by the jury. By 13 & 14 Car. II., cap. 12, when a constable dies or goes out of the parish, any two justices may make and swear a new one until the lord shall hold a court-leet; and if any officer continue above a year in his office, the justices in their quarter-sessions may discharge him, and put another in his place until the lord shall hold a court. But the justices at sessions cannot discharge a constable appointed at the leet; and though they can appoint constables until the lord shall hold a court, they cannot appoint for a year, or till others be chosen. A person chosen constable who is deficient in honesty, knowledge, or ability, may be discharged by the leet or by the Court of King's Bench as unfit. The steward may set a reasonable fine on a constable or tithing-man refusing to make presentments.

Though the leet has long ceased to be the principal and ordinary court of criminal jurisdiction, its power and authority have been enlarged by several statutes, which give it cognisances over offences newly created, and it does not appear to have been at any time directly abridged by legislative interference. The business of the court has chiefly been affected by the creation of concurrent jurisdictions, particularly that of justices of the peace [JUSTICES OF THE PEACE], who have cognisance of the same matters, as well as of many others over which the court-leet has no jurisdiction. Justices of the peace are always accessible, whereas the court-leet is open only at distant intervals, and for a short period, unless it be continued by adjournment, which can only take place for the despatch of existing business. Another cause of the declension of these tribunals is that except in a very few cases the jurisdiction of the leet is confined to offences punishable at common law. In statutes providing for the repression of new offences, the leet is commonly passed over in favour of justices of the peace. Blackstone reckons "the almost entire disuse and contempt of the court-leet and sheriff's tourn, the king's ancient courts of common law formerly much revered and respected, among the mischievous effects of the change in the administration of justice by summary proceedings before justices of the peace." It was not, however, left to the learned commentator to make this discovery. In the course of the very reign which witnessed the introduction of the modern system of justices of the peace, we find the Commons remonstrating against the violation of the Saxon principle of self-government and domestic administration of justice, resulting from the encroachments made upon the ancient jurisdiction of the leet by giving to the new tribunal of the justices of the peace a concurrent jurisdiction in matters usually brought before the court leet, and an exclusive jurisdiction in other important matters. In the last year of Edward III. (1377), the Commons, by their petition in parliament, prayed the king that no justice of the peace should inquire of anything cognisable in the courts of lords who had view of frank-pledge, or of anything cognisable in any city or borough within their district, and should attend only to the keeping of the peace and the enforcing of the statute of labourers. To this petition the king returned the following unsatisfactory answer:—"The statutes heretofore made cannot be kept if the petition be granted." At this time, and until the passing of 27 Hen. VIII., c. 24, offences in leets were alleged to be against the lord's peace, not the king's.

IV. *Manner of holding the Court-leet.*

The common notice of holding the court is said to be three or four days; but it is now usual to give fifteen days' notice. An amercement at a court of which sufficient notice has not been given is void. But even where there is a clear prescriptive usage to give a certain number of days' notice, the resiants cannot disturb the holding of the court on the ground that such notice has not been given.

The functions of the steward of a court-leet are mostly, if not wholly, judicial. Ministerial acts are to be performed by an inferior officer called the bedel or bailiff, who of common right is appointed by the lord or steward, though by custom he may be chosen by the jury, and sworn with the other officers chosen at the leet; and where, in a leet appendant to a borough, the bailiff so chosen has a discretionary power in impannelling the jury, this important function is a sufficient ground for issuing a quo warranto to inquire into the title of the party exercising it. The steward, at the customary or at a resonable time before the holding of the court, issues a precept under his seal, addressed to the bailiff of the leet, commanding him to warn the resiants to appear at the time and place appointed for holding the court, and to summon a jury. The notice may be given in the church or market, according to the usage of the particular place; but it is said that if it be not an ancient leet, personal notice is necessary. According to the course most usually pursued, the steward opens the court by directing the court to be proclaimed; and this being the king's court, it is necessary that three proclamations should be made. This is done by the bailiffs crying 'Oyes' (hear) three times, and then saying once 'All manner of persons who are resiant or deciners and do owe suit royal to this leet, come in and do your suit and answer to your names upon pain and peril which shall ensue.' The bailiff then delivers to the steward a list of persons summoned as jurymen, together with the suit or resiant roll. The suit-roll is then called over, and those resiants who are absent are marked to be amerced. The bailiff then makes three other proclamations, by crying 'Oyes' three times, and then saying 'If any man will be essoigned, come in, and you shall be heard.' The steward having called for the essoigns, enters them. The essoigns should regularly be adjourned to the next court for examination in the court roll or book.

Suit-real must be done in person; it cannot be done by attorney; nor can it, as it would seem, be released by the lord. But the suitor may be essoigned or excused *pro hâc vice*, which is done generally upon the payment of an essoign penny.

The constables are next examined as to their compliance with the orders received by them at the previous court. After this the leet jury is formed. This jury is chosen from the body of the suitors, and consists of not less than twelve, nor more than twenty-three. In some leets the jury continues in office for a whole year; in others the jurors are elected and discharged in the course of the day. A custom for the steward to nominate to the bailiff the persons to be summoned on the jury is valid. If a sufficient number of resiants to form a jury cannot be found, the steward has power to compel a stranger to serve, even though he be merely travelling through the district, and is actually riding on his journey at the time his services are required; but a woman, though a resiant, cannot be sworn.

After the jury is chosen a foreman is named, who is sworn as follows:—"You shall well and truly inquire, and true presentment make, of all such articles, matters, and things as shall be given you in charge; the king's counsel, your companions', and your own, you shall keep secret and undisclosed. You shall present no man for envy, hatred, or malice; nor spare any man for fear, favour, or affection, or any hope of reward; but according to the best of your knowledge, and the information you shall receive, you shall present the truth and nothing but the truth." As soon as the foreman is sworn, three or four of the jury, taking the book together, are sworn to observe and keep, on their parts, the same oath which the foreman has taken on his part. The jury then receive a charge from the steward, pointing out the nature of their duties, and of the matters which ought to be presented. The jury make their presentments to the steward, who, in cases of treason or felony, must return the presentments (in these cases called indictments) to the justices of gaol delivery if the offenders be in custody; if they be at large, the indictments must be removed into the King's Bench by certiorari, in order that process may issue thereon. In all other cases the steward of the leet has power, upon the complaint of any party grieved by the presentment, or, on the other hand, upon any suspicion entertained as to the concealment of any offence, by non-presentment, to cause an immediate inquiry into the truth of the matter by another jury, though in the former case the more usual course now is by certiorari or traverse.

A court-leet may be adjourned if the business of the particular court require it. This should be done by three proclamations. A court held on the 28th April, and adjourned, after the jury had been sworn, till the 15th December, which day was given them to make their presentments, has been held not to be necessarily unreasonable.

It is not necessary that notice should be given of an order made by the leet for abating a nuisance; the party being within the jurisdiction, must take notice of it at his peril. For the same reason he is also bound to take notice of a by-law.

V. *Profits of Court.*

The ordinary profits of a court-leet are the fines, amercements, and essoign pence, and belong, in the case of a public leet or tourn, to the crown; in the case of a private leet, to the grantee or lord of the leet. It would rather seem, however, that the lord is bound to account at the Exchequer for these profits, though he may discharge himself by showing his title. In a private leet also, the lord, as above mentioned, is entitled to a further payment, in the nature of a poll-tax, capitagium, or chevage, by the name of certum letæ, sometimes called cert-silver, certainty-money, cert-money, and head-silver. When this payment is to be made on the day of the leet the defaulters may be presented and amerced. For such amercement the lord may distrain; but he cannot distrain for the cert-money itself, without a prescription to warrant such distress. In the absence of both amercement and prescription, the lord's remedy is by action of debt.

LEGACY (Legátum), a bequest or gift of goods and chattels by will or testament. The person to whom it is given is termed the legatee (legatárius); and every person is capable of being a legatee, unless particularly disabled by the common law or by some statute.

The bequest in no case confers more than an inchoate property on the legatee, which does not become complete until the assent of the executor or administrator with the will annexed, as the case may be, has been given. [EXECUTOR.] But, before such assent, the bequest is transmissible to the personal representatives of the legatee, and will pass by his will.

Legacies are of two kinds, general and specific. A legacy is general when it is so given as not to amount to a bequest of a particular thing, or a particular fund of the testator; a specific legacy is a bequest of a specified thing, or a specific part of the testator's estate. The whole of the estate of a person deceased being liable for the payment of his debts, legacies of both kinds are of course subject to debts: but in case of a deficiency of the estate for the payment of the legacies, the general legatees can only be paid in equal proportion; and they must, as it is technically termed, *abate.* But a specific legatee is not compelled to abate or allow any thing by way of abatement, though his legacy may be taken for the payment of debts, in case the general legacies have all been applied to pay them and there is still a deficiency to meet the demands on the estate of the deceased. Specific legatees may, however, be compelled to abate as against one another. If the part of the testator's estate which is specifically given has been disposed of by the testator in his lifetime, or at the time of his death has ceased to exist in such form as described in his will, the general rule is, that the specific legatee loses his legacy, and is not entitled to any satisfaction out of the general estate: in such case the legacy is said to be adeemed, a term which has been derived from the Roman law, though the word 'adimere' is not there used exactly in this sense. (*Dig.* 34, 4.) There is also a third description of legacy partaking somewhat of the nature of both kinds already mentioned, as a gift of so much money, with reference to a particular fund for payment. This is called a *demonstrative* legacy, but so far differs from one properly specific, that if the fund pointed out fails on any account, the legatee will be paid out of the general assets; yet it is so far specific that it is not liable to abate in case of deficiency of the general assets.

Legacies may be given either absolutely (puré) or upon condition (sub conditione), or upon the happening of any contingency; provided it must happen, if at all, within the duration of a life or lives in being at the time of the decease of the testator and twenty-one years afterwards, allowing in addition the period of gestation where the contingency depends upon the birth of a child. Legacies may also be given in such a way that though no condition is expressed in distinct terms, it may be clearly inferred that the testator did not intend his gifts to take effect till a definite time had arrived or a definite event had taken place. When a legatee has obtained such an interest in the legacy as to be fully entitled to the property in it, the legacy is said to be *vested,* and this property may be acquired long before the right to the possession of the legacy accrues. A vested legacy partakes of the incidents of property so far as to be transmissible to the personal representatives of the party entitled to it, or to pass by his will; a legacy which is contingent or not vested is no property at all with respect to the legatee. This distinction of legacies, vested or not vested, seems derived from the Roman law, which expresses the fact of vesting by the words 'dies legati cedit.'

Formerly, in all cases when a legatee died before the testator, the legacy lapsed, or failed, and went to the person appointed residuary legatee by the testator, or if there was none such, to the next of kin; and lapse might also take place (as already observed with respect to a legacy given to a legatee at a particular time, or upon condition, or the happening of a contingency) if the legatee died before the appointed time arrived, or if the condition was not performed, or the contingency did not happen. The Wills Act, 1 Vict. c. 26, sect. 33, modified the old rule, and directed that when legacies are bequeathed to a child or other issue of the testator who shall die in his lifetime, leaving issue, and such issue shall be living at the testator's death, the legacies shall not lapse unless a contrary intention appears upon the face of the will, but shall take effect as if the legatee had died immediately after the testator.

The rules by which gifts of legacies are construed are derived from the civil law, or rather are a part of that law, which prevailed in the ecclesiastical courts while those courts had jurisdiction over legacies; for although the Court of Chancery had concurrent jurisdiction with the ecclesiastical courts, yet to prevent confusion it followed the same general rules. If, however, a legacy be charged upon or made payable out of the real estate, then, as the ecclesiastical court had no concurrent jurisdiction, courts of equity are not bound to follow the same rules as to the construction of such gifts as in the case of personal estate.

The questions involved in the law relating to legacies are so numerous that it is quite impossible even to notice them in an article of this description; and as they are chiefly of a technical nature, the reader is referred to the various treatises on that branch of the law.

Generally speaking an executor cannot be compelled to pay legacies until after the expiration of twelve months from the decease of the testator, and not even then unless the assets should be realised and the debts paid or provided for; but as the rule is only for the general convenience of executors, if it should appear that all the debts of the testator are paid, the executor may be compelled to pay the legacy before the twelve months have expired. It may be stated, however, as a general rule, that legacies are payable twelve months after the death of a testator, and with interest from that time at 4 per cent., unless the testator has made some special provision as to time of payment and interest. The rule as to the twelve months is taken from the Roman law. It has already been stated in this work [EXECUTOR], that an action at law does not lie for a legacy, until after the executor has admitted that he has assets in his hands sufficient to make the payment, or in the case of a specific legacy, has assented to it. But the law may perhaps be more correctly stated thus: Where a specific legacy consists of some determinate chattel, whether real, as a lease for years, or personal, as a particular horse, the legatee, after assent by the executor to the legacy, may take possession of it, or sue for it by action at law; but where the specific legacy consists of money, &c., and in all cases of general and of demonstrative legacies, no action at law lies unless the executor has, for some new consideration beneficial to himself, expressly promised payment. As a general rule, therefore, it may be stated that the remedies by legatees against executors are afforded by the courts of equity. (Roper *On Legacies;* Williams *On Executors.*)

On the subject of legacies (legata) under the Roman law, Gaius (ii., 192-255) and the *Digest,* lib. XXX., XXXI., XXXII., 'De Legatis et Fidei commissis,' are the authorities. This is one of the subjects on which the Roman jurisconsults have most successfully exercised their sagacity and diligence.

LEGACY DUTIES. [PROBATE DUTIES.]

LEGATE (from the Latin, Legátus). This word had various significations among the Romans. The legates were the chief assistants of the proconsuls and proprætors in the administration of the provinces. The number of legates differed according to the quality of the governor whom they accompanied; their duties consisted in hearing inferior causes and managing all the smaller affairs of the government. They appear to have been chosen and appointed by the governor, though at the first institution of the office it would seem they were selected by the senate, as advisers to the governor, from the wisest and most prudent of their own body. The word legatus also signified a military officer who was next in rank to the general or commander-in-chief in any expedition or undertaking, and in his absence had the chief command. (Cæsar, 'De Bell. Civ.,' ii., 17.) The word legatus is often used to denote a person sent by the Roman state to some other state or sovereign power on matters that concerned the public interest: in this sense the word corresponds pretty nearly to our ambassador or envoy, except that the motives for sending a legatus, or legate, seem to have been occasional only, and the legates do not appear ever to have been permanent resident functionaries in a foreign community. Under the emperors those who were sent by them to administer the provinces of which the government was reserved to the emperors, were called legates.

Under the republic the senators who had occasion to visit the provinces on their own business used to obtain what was called a 'legatio libera,' that is, the title and consideration of a legatus, or public functionary, with the sole object of thereby furthering their private interests. These legationes are said to have been called liberæ, or free, because those who held them had full liberty to enter or leave the city, whereas all other public functionaries whose duties were exercised beyond the limits of the city could not enter Rome till they had laid aside their functions; or because a senator could not go beyond a certain distance from Rome unless he obtained permission in the form of a legatio. Cicero, who on one occasion inveighs vehemently against the legatio libera, could defend it when it suited his purpose; and in a letter to Atticus (i. 1) he expresses his intention to visit Cisalpine Gaul in this capacity for the purpose of furthering his election as consul.

At the present day a legate signifies an ambassador, or nuncio, of the pope. They are of the highest class of ambassadors; but are not recognised in Great Britain. [AMBASSADOR; NUNCIO.]

There are several kinds of papal legates, *legatus a latere*, *legatus natus*, &c. Legates a latere are sent on the highest missions to the principal foreign courts, and as governors of provinces of the Roman dominion, thence called legations. Legatus natus is a person who holds the office of legate as incident and annexed to some other office, and is, as we should say, a legate *ex officio*. As this office or title exempted the holder from the authority of the legates a latere, it was earnestly sought after by the bishops. The archbishop of Canterbury was formerly a legatus natus, and in 1100, Guido, archbishop of Vienne, having been sent to England as legate by the pope, was not allowed by Henry I. to exercise his office. There are now three or four German bishoprics permanently invested with the privileges of the office. Legates of a lower rank than cardinals are called nuncii apostolici.

LEGEND (from the Latin word *legendum*, a thing to be read) is used commonly in the sense of fabulous or doubtful narratives, such as the exploits of heroes of the middle times between history and fiction, tales of superstition, or other subjects, in which credulity and imposture find free room for exercise. Thus legends have come to signify that which is usually rather matter of tradition than of written evidence. In old authors the word occurs in its simple meaning.

Legend is also used technically to denote the words encircling a coin; to writing on tablets the word *inscription* is applied, which is also used instead of legend where a sentence, instead of encircling, occupies the place of a device on the coin.

LEGER *Lines and Spaces* (*Leger*, Fr., *light*), in Music, the lines and spaces added to the staff when the notes exceed the ordinary compass. The word is often improperly written *Ledger*.

LEGION. In a Roman consular army each grand division, corresponding nearly to a modern brigade, was so denominated; and the word indicates a selection of the individuals composing such division. The name is still occasionally given to a body of troops consisting of several regiments or battalions, when raised at a particular place or for a particular service.

The strength of a Roman legion varied at different periods. When Romulus divided the citizens of his newly-formed state into three portions or tribes, he also divided the men who were able to bear arms into bodies of 3000 men, and each of these constituted a legion, which was commanded by one or three præfects or tribunes. (Plutarch, in 'Rom.') Servius Tullius, who, by the enlargement of the city, formed a fourth tribe, is supposed to have raised the strength of the legion to 4000 men. About 150 years afterwards, when Camillus marched against Satricum, he had four legions, each of which consisted of that number of men (Liv., i. 22); but, twenty years later, the strength of the legion is stated to have been 5000 foot and 300 horse. (Liv., viii. 8.) This probably continued to be the general establishment of that body of troops, though particular circumstances might cause it to be occasionally increased. Scipio landed in Africa (Liv., xxix. 24) with two legions, each consisting of 6200 men (though the best commentators suppose that 5200 is meant); and while the Roman army was acting against Perseus in Macedon, each legion contained 6000 foot and 200 horse. (Liv., xliii. 12.) Vegetius, who lived in the 4th century, describes the legion (lib. ii., cap. 6) as a body consisting of 6100 foot soldiers, besides 720 horsemen; but he designates this the ancient legion, and his account is probably applicable only to the state of that body in the age of Hadrian and the Antonines. The legion declined under the later emperors, and in the time of Constantine it appears to have consisted of only 1500 men.

During the reign of Augustus twenty-five legions were placed permanently on the frontiers of the empire; and in the time of Hadrian the number of legions composing the Roman army was 30, exclusive of the auxiliaries. Their disposition in Italy and the provinces may be seen in Gibbon, vol. i., ch. 1. The legions were denoted by numbers, and they were further designated by the name of the emperor who raised them, or by the name of the place where they were raised, or where they had distinguished themselves.

The manner in which the soldiers were elected to serve in the legions is fully described by Polybius (book vi., ch. 1), who lived in the age of Fabius and Scipio; and it may be presumed that this was in accordance with the prescribed regulations, which however were only followed when the necessities of the state did not compel the magistrates to dispense with them. When an army consisting of four legions was to be raised, the citizens of the proper ages being assembled on an appointed day in the Capitol, the military tribunes drew out the tribes by lot, and from that which was first called they selected four men of nearly equal age and stature: of these the tribunes who were appointed to the first legion chose one; those who were appointed to the second legion chose another; and so on. Afterwards the whole body of the tribunes chose four other men, and of these the tribunes of the second legion first chose one; those of the third legion then chose another; and so on, the tribunes of the first legion taking the last man of the four. In like order the election proceeded, till the required number of men was obtained. Polybius states that, in his time, the horsemen were enrolled before the foot soldiers, but that anciently the former were chosen last.

Immediately after the enrolment, the recruits for the legions being made to advance one by one, each was sworn to be obedient to his commanders, and to execute all the orders which he should receive from them to the utmost of his power.

When soldiers were to be raised from the allied cities of Italy, notice appears to have been sent by the consuls to the magistrates of those cities, who then enrolled men in a manner similar to that which was practised at Rome; and, having caused them to be disciplined, sent them to join the army.

On the institution of regular bodies of troops by Romulus, he is said to have divided them (probably each legion) into companies of 100 men, and these were called *Manipuli*, from the bundles of grass which served as standards for the people who accompanied him when he attacked the palace of Amulius. (Aur. Victor, 'Origo Gen. Rom.,' c. 22.) The first mention of a cohort occurs shortly after the expulsion of the kings (Liv., ii. 11); and in the time of Polybius the legion was divided into ten cohorts, each of these into three manipuli (Polyb., b. xi.), and each of the latter into two centuriæ. [COHORT.] A manipulus must have then consisted of 200 men; and at a later period it designated a body of less than the original number. Two *Centuriones* were appointed under each *Manipulus*: each *Centurione* had under him two *Sub-Centuriones*, and a standard-bearer (*Signifer*). Beneath these were the *Decuriones*. Under Hadrian and the emperors immediately following him the cohorts appear to have been of unequal strength. Vegetius states that the first, which was called *cohors milliaria*, and which carried the eagle, consisted of 1500 foot and 132 horsemen; the second, called *cohors quingenaria*, of 555 foot and 70 horsemen; and that the remaining cohorts were nearly of the same strength as the second.

Servius Tullius is said to have divided the military force into five different classes of troops (Liv., i. 43), which were distinguished by their armour; but from the commencement of the republic, or nearly so, the order of battle consisted of three lines of troops, the *Hastati*, the *Principes*, and the *Triarii* (Liv., viii. 8.) The *Velites* (light troops or skirmishers) had no particular station, and except the latter, all the troops, according to Polybius, were armed nearly in the same manner.

The youngest men were selected to act as velites: they were armed with bows or slings, and some of them carried a light javelin. After the time of Marius these ceased to be enrolled as legionary troops, and were chiefly foreigners. Vegetius designates them *Ferentarii*. They wore short swords, and were provided with bucklers of a circular form, about three feet in diameter. The staff of their javelin was two cubits long, and as thick only as a finger; the iron head tapered gradually to a fine point, in order that, being bent at the first discharge, it might be rendered useless to the enemy.

The hastati of all the cohorts were stationed in the first line; the principes formed the second, those of each cohort supporting their own hastati; and the triarii were similarly disposed in the third line to support the principes. All the three classes were completely armed with cuirass, helmet, and greaves; their buckler was 4 feet long and 2½ feet broad, and five arrows were placed in its concavity, to be thrown when necessary. Each man was provided with a long and a short sword, the blade of the former being strong, and made either to cut or thrust; and he carried, besides, two javelins, or *pila*. (Polyb., b. vi.) The only difference in the arms of the three classes seems to have consisted in the size of the *pilum*, those used by the triarii, or veteran soldiers, in the time of Varro being longer and heavier than those of the men in the other lines.

It is supposed that originally the principes were stationed in the first line, and that they were men of the superior classes; from which circumstance, or because they came first into action, they may have acquired their designation.

The front of the legion, when in order of battle, was formed by ten corps of the hastati, each corps being arranged with 16 men in front, and 10 in depth. The second line, or that of the principes, was of the same strength, and was drawn up in the same manner. The line of triarii consisted also of ten corps; but these had only 10 men in front and 6 in depth. Every legionary soldier was allowed five feet in front, and as much in depth, in order that he might be enabled to make free use of his arms.

The cavalry of a Roman legion was divided into ten *turmæ*, of about 30 horsemen each, who, in order of battle, were drawn up with 8 in front, and 4 in depth. Each legion of the allies had however 600 horsemen; so that the cavalry of a consular army (consisting of two Roman legions and two legions of allies) amounted to 1800 men, who were disposed on the wings of the legion, in one line or two, according to circumstances. The legionary cavalry were furnished with cuirasses and helmets, and they were accompanied by light-armed horsemen, who served as archers.

LEGION OF HONOUR, an order of merit in France, owes its origin to article 87 of the constitution of 1800, which provided that "national recompenses should be bestowed on the warriors who had performed brilliant services," and this principle was organised to some extent by the joint consuls. Napoleon I., when consul for life, established and endowed it early in the year 1802, notwithstanding some opposition from the legislative body, who, however, gave their sanction on the 19th of May. It was to be a recompense for military and civil services. The order consisted of five divisions: *chevaliers*, of whom the number was unlimited, *officers*, *commanders*, *grand officers*, and *grand crosses*.

The Legion of Honour, though it undoubtedly seemed a forerunner to that new nobility which Napoleon, in after years, collected around his imperial throne, soon became an institution in the highest degree important to his interests, and popular among the nation; and has outlived the fortunes of its founder. Its benefits were appreciated by the Bourbons, who soon discovered that it was the most powerful means they could employ of increasing their popularity, and giving stability to their precarious position. The ordonnance of July 19, 1814, however, made some material changes. The right of members of the Legion to vote in the electoral colleges was abolished; the pensions were continued to the titularies already in receipt of them, but only in proportion to the actual income of the body; and future appointments were to convey no such right. On the return of Bonaparte in 1815, he ordered the payment of the arrears, and the restoration of the political privileges of the members. On his downfall the Legion of Honour again felt the resentment of the restored monarch. In Dec., 1816, the pensions of the legionaries were provisionally reduced one-half; but this measure was repealed by the legislative bodies in 1820. Under the two dynasties of Bourbons, the decoration was worn on the breast of an Arago, a Guizot, and a Thiers, with equal honour, and as much applause, as it had been on those of a Ney, a Masséna, and a Lannes. It is to the credit of the French nation that, while no other people are perhaps so much under the influence of military renown, it would be difficult to mention the name of any other country where men of science and literature are more generally esteemed and rewarded. The revolution of 1848, and the elevation of Napoleon III. to the empire, have changed nothing in the institution of the Legion of Honour, except by substituting the tri-color flag instead of those ornamented by fleurs-de-lis.

LEGISLATION. Under this head of legislation, may be considered, 1st. The meaning of the word; 2nd. The distinction between the legislative and executive powers; and 3rd. The difference between jurisprudential and legislative science.

1. *Etymology of the word.*—A magistrate who proposed a law in Rome for the adoption of the assembly of citizens was said *legem ferre* (as we say, to *bring* a bill into parliament); and the law, if carried, was said to be *perlata*, or simply *lata*. Hence the term *legum lator*, or *legislator*, was used, as synonymous with the Greek *νομοθέτης*, in the sense of a lawgiver. From *legislator* have been formed *legislation*, *legislative*, and *legislature* (the latter word signifying a person or body of persons exercising legislative power).

Legislation means, therefore, the making of positive law. Positive law [LAW] is made by the person or persons exercising the sovereign power in a community. The end of positive law is the temporal happiness of the community.

2. *Distinction between legislative and executive powers.*—A general command, or law, issued by a sovereign power would be nugatory, if it were not applied in practice to the cases falling within its scope, and if the pains denounced for the violation of it were not inflicted on transgressors. The execution of such general commands or laws is therefore an essential part of the business of a government.

An *executive* command, or act, of a government, or other authority, is a special command issued, or act done, in the execution of a law previously established by the legislative power. These executive commands or acts are of two sorts, namely, *administrative* and *judicial*; and the distinction between them may (in conformity with modern phraseology) be thus stated. A judicial proceeding is a declaration, by a competent authority, that a person has (or has not) brought himself within the terms of a certain penal provision, or that he has (or has not) a certain legal right or obligation which another disputes with him. An administrative proceeding is for the sake of carrying a rule of law into effect, where there is no question about the legal culpability, or dispute about a legal right or obligation of a person. In an administrative proceeding the government functionary acts, or may act, spontaneously; in a judicial proceeding he does not act until he is acted upon by others. A judge cannot act until his court is (to use the French phrase) *seized*, or *saisi*, with the question; or (to use the language of our ecclesiastical courts) it is necessary "to promote (or set in motion) the office of judge." (Dégérando, 'Institutes du Droit administratif Français,' Paris, 1829.)

The distinction between the making of laws and their execution is too obvious to have been overlooked by the ancient writers on government. The latter subject was treated by them under the head of *magistrates*. (For example, Aristot., 'Pol.,' vi. 8.) The distinction has, however, attracted peculiar attention from both speculative and practical politicians since the beginning of the last century, in consequence of the great importance attributed by Montesquieu to the separation of the legislative, administrative, and judicial powers of government; that is, the exercise of the administrative and judicial functions by officers distinct from the supreme legislative body, and from each other. ('Esprit des Lois,' xi., 6.)

The legislative functions of a government can be distinguished, logically, from its executive functions; but these functions cannot, in every case, be severally vested in different persons. In every free government (or government of more than one) the legislative bodies exercise some executive functions: thus, in England, the House of Lords is an appellate court in civil cases, and the House of Commons decides in cases of contested elections of its own members. In every form of government the public functionaries, whose primary business is the execution of the laws, exercise a considerable portion of (delegated) legislative power. It is scarcely possible to conceive a body of law so complete as not to require subsidiary laws for carrying the principal laws into execution, and a power of making these subsidiary laws must, to a greater or less extent, be vested in the executive functionaries.

3. *Difference between jurisprudential and legislative science.*—Positive law may be viewed in the two following aspects. First, it may be considered as an organic system, consisting of coherent rules, expressed in a technical vocabulary. Secondly, its rules may be considered singly, with reference to their tendency to promote the happiness of the community; in other words, their expediency or utility. Law viewed in the former aspect is properly the subject of the science of jurisprudence. [JURISPRUDENCE.] Law viewed in the latter aspect is the subject of a department of political science which is generally termed *legislative science*. (Legislation, in strictness, is concerned about the technical form, as well as the utility, of a law; but the term legislative science, as just defined, is sufficiently accurate for our present purpose.)

It is important to bear in mind the distinction, just pointed out, between the scientific or technical excellency of a system of law, and the expediency or utility of the rules of which it is composed. The distinction, however manifest, has been frequently overlooked, even by lawyers. Thus Sir W. Blackstone, in describing the struggle made by the clergy to substitute the Roman law for the common law of England, gives the preference to the latter system on the ground of the imperial government of Rome being despotic. The excellence of a system of law, considered in a scientific point of view, has no connection with the form of the government by which the laws were established. Law may be, and has been, cultivated as a science with admirable success under very bad governments. The scientific cultivation of law in Rome scarcely began until the Empire; and the great legal writers of France lived in times of political anarchy or despotism. A system of law of which the practical tendency may be most pernicious, may have the highest scientific or technical excellence. A code of laws establishing slavery, and defining the respective rights and duties of master and slave, might be constructed with the utmost juristical skill; but might, on that very account, be the more mischievous as a work of legislation. On the other hand, a system of law may be composed of rules having a generally beneficial tendency, but may want the coherency and precision which constitute technical excellence. The English system of law affords an example of the latter case. Owing to the popular character of the legislature by which its rules were enacted or sanctioned, it has a generally beneficial tendency; but considered in a scientific point of view it deserves little commendation. The writings of Mr. Bentham, in like manner, are far more valuable contributions to legislative than to jurisprudential science. The remains of the writings of the Roman lawyers, on the other hand, are of little assistance to the modern legislator, but they abound with instruction to the jurist.

The distinction between the technical excellence of a law and its expediency, or (in other words) between its form and its substance, is also important with reference to the question of *codification*, that is, the making of a code of laws.

The making of a code of laws may involve any one of the three following processes:—1. The formation of a new system or body of laws. 2. The digesting of written laws, issued at various times, and without regard to system. 3. The digesting of unwritten law, contained in judicial decisions and authoritative legal treatises. The ancient codes of law were, for the most part, works of new legislation; such were, for example, the codes of Solon and Draco, the Twelve Tables, the code of Diocles of Syracuse, and others. The *codices* of Theodosius and Justinian afford examples of the digesting of written laws. The Digest or Pandect of Justinian affords an example of the digesting of unwritten law. The French codes were not digests of the existing law of France, either written or unwritten; but they were in great measure founded on the existing law. The same may be said of the Prussian Landrecht. The statutes for consolidating various branches of the criminal law of England, the bankruptcy laws, the customs laws, &c., are instances of the digesting of the written law of England. The specimens hitherto furnished by different commissions of a digest of the English common (or unwritten) law have only been such as to prevent their being thrown into the shape of written law. The digesting of existing law, whether written or unwritten, requires merely juristical ability; the making of new laws requires in addition to the knowledge and skill of the jurist, that ability which we have termed legislative. In other words, the making of new laws requires both attention to their utility or expediency, and technical skill in the composition or drawing of them. Popular forms of government secure a tolerably careful examination of laws, with reference to their expediency; but they do not secure attention to the technical or scientific department of legislation. Indeed nearly all the principal codes of laws have emanated from despotic governments, namely, the Roman, Prussian, Austrian, and French codes. The difficulty of passing an extensive measure through a popular legislature has been urged by those who have been reproached with failure, as discouraging any attempt at a systematic digesting of the law. But the digest of the law of the state of New York, and other American codifications, afford instances that such difficulty is not insurmountable.

The inconveniences arising from too great prolixity or too great conciseness in the phraseology of laws are stated by Lord Bacon, in the 66th and 67th aphorisms of his eighth book 'De Augmentis.' If an attempt be made, by an enumeration of species, to avoid the obscurity which arises from the use of large generic terms, doubts are created as to the comprehensiveness of the law; for, as Lord Bacon well observes, "Ut exceptio firmat vim legis in casibus non exceptis, ita enumeratio infirmat eam in casibus non enumeratis." ('Ib.,' aph. 17.) On the other hand, vague and extensive terms, if unexplained, are obscure and frequently ambiguous. The best mode of producing a law which shall at once be comprehensive, perspicuous, and precise, probably is, to draw the text of the law in abstract and concise language, and to illustrate the text with a commentary, in which the scope, grounds, and meaning of the several parts of the law are explained. Such a commentary was suggested by Mr. Bentham. ('Traités de Legislation,' tom. iii., p. 284; 'De la Codification,' s. 4.) Doubts will arise in practice respecting the interpretation of the most skilfully drawn laws; and the best guide to the interpretation of a law is an authentic declaration, made or sanctioned by the legislature which enacted it, of its scope or purpose. The want of such a commentary frequently causes the scope of a law to be unknown; and hence the tribunals often hesitate about enforcing laws which may be beneficial. ('Dig.,' lib. i., t. 3, fr. 21, 22.)

It seems scarcely necessary to say that laws ought, where it is possible, to be composed in the language most intelligible to the persons whose conduct they are to regulate. In countries where the great majority of the people speak the same language (as in England or France), no doubt about the choice of the language for the composition of the laws can exist. In countries however where the people speak different languages, or where the language of the governing body differs from that of the people, or where the bulk of the people speak a language which has never received any literary cultivation, a difficulty arises as to the language in which the laws shall be written. Where the people speak different languages, authentic translations of the original text of the laws should be published. Where the language of the governing body differs from that of the people (which is generally the case in newly-conquered countries), the laws ought to be issued in the language of the people. It is comparatively easy for a small number of educated persons to learn a foreign language; whereas it is impossible for the people at large speedily to unlearn their own, or to learn a new tongue. Where the language of the bulk of the community has not received a literary cultivation, the language used by educated persons for literary purposes must be employed for the composition of the laws. Thus in Wales, the Highlands of Scotland, and the west of Ireland, the language of the laws and the government is not Celtic, but English; and in Malta, where the bulk of the people speak a dialect of Arabic, the laws are published and administered in Italian, which is the literary language of the island.

LEGITIMATION. [Bastard.]

LEGUMIN. *Vegetable Casein.* This body has already been referred to [Albumen] as one of the members of the *albuminoid* or *protein* group of substances. It exists in the seeds of all leguminous plants, but is best prepared from peas or sweet almonds. These are bruised, digested in lukewarm water for two or three hours, strained, reduced to a pulp in a mortar, the mass digested in its own weight of cold water for an hour, the whole thrown upon a cloth filter, and finally pressed. The resulting liquor is then set aside for a short time that starch may deposit, is filtered, and dilute acetic acid added to it cautiously drop by drop. The legumin is thus precipitated in flocks, it is first washed with water, then with alcohol, dried, powdered, digested in ether to separate fatty matter, and finally exposed in vacuo to a temperature of 284° Fahr. till all moisture is got rid of.

Legumin is insoluble in cold alcohol or ether. It is readily soluble in cold water, the solution coagulating on boiling; a trace of alkali, however, prevents the coagulation. Acids also cause the precipitation of legumin from solution, and redissolve it if they are added in excess. Ebullition with dilute sulphuric acid converts it into leucin. A piece of rennet has the same action upon solution of legumin that it has upon milk. Legumin or vegetable casein further resembles the animal casein contained in milk, in the spontaneous curding of its solution when set aside for some hours, the supernatant liquid or vegetable whey containing lactic acid like milk whey.

According to Dumas and Cahours, legumin contains:—

Carbon	50·53
Hydrogen	6·91
Nitrogen	18·15
Sulphur Oxygen	24·41
	100·00

Some experimenters, however, find more carbon and less nitrogen; the sulphur appears to be present to the extent of 0·51; and Voelcker finds 2·18 of phosphorus in legumin. By oxidation legumin gives formic, acetic, and other acids of the series $C_nH_nO_4$.

Legumin, like the other members of the albuminoid group, is an important flesh-forming material. [Albumen.]

LEIOGOMME is the name given to a substance possessing the properties of gum, and which is produced by simply exposing starch to a temperature of 300°. It has a brownish-yellow colour, and acts in the same manner as gum, and is extensively used instead of this substance in calico-printing. It is identical with Dextrin.

LEIPSIC YELLOW. [Colouring Matters.]

LELEGES. The history of this people is involved in great obscurity, in consequence of the various and almost contradictory traditions which exist concerning them; according to which, they are on the one hand represented as among the earliest inhabitants of Greece, while on the other they are said to be the same people as the Carians. They were probably, as Strabo considers them, a mixed race widely diffused. According to Herodotus, the Carians, who originally inhabited the islands of the Ægean Sea, were known by the name of Leleges before they emigrated to Asia Minor (i. 171); and according to Pausanias, the Leleges formed only a part of the Carian nation (vii. 2, § 4). The Leleges appear, from numerous traditions, to have inhabited the islands of the Ægean Sea and the western coasts of Asia Minor from a very early period. In Homer they are represented as the allies of the Trojans, who inhabited a town called Pedasus, at the foot of Mount Ida; and their king, Altes, is said to be the father-in-law of Priam. ('Il.,' xx. 96; xxi. 86.) They are said to have founded the temple of Hera in Samos (Athen. xv., p. 672, Casaubon); and Strabo informs us that they once inhabited, together with the Carians, the whole of Ionia (vii. p. 331).

On the other hand, in the numerous traditions respecting them in the north of Greece, we find no connection between them and the Carians. According to Aristotle (quoted by Strabo, vii. p. 322), they inhabited parts of Acarnania, Ætolia, Opuntian Locris, Leucas, and Bœotia. In the south of Greece we again meet with the same confusion in the traditions of Megara respecting the Leleges and Carians. Car is said to have been one of the most ancient kings of Megara, and to have been succeeded in the royal power after the lapse of twelve generations, by Lelex, a foreigner from Egypt. (Paus., i. 39, § 4, 5.) Pylus, the grandson of this Lelex, is said to have led a colony of Megarian Leleges into Messenia, where he founded the city of Pylus. (Paus., iv. 36, § 1.) The Lacedæmonian traditions, on the contrary, represent the Leleges as the original inhabitants of Laconica. (Paus., iii. 1, § 1.)

It can scarcely be doubted, from the numerous traditions on the subject, that the Leleges were in some manner closely connected with the Carians; though it seems improbable that they were, according to Herodotus, the same people. The Carians are universally represented as a people of Asiatic origin; while the principal and apparently earliest settlements of the Leleges were on the continent of Greece. With the single exception of the Megarian tradition mentioned above, the Leleges are nowhere represented as foreign settlers. If we might venture to form an opinion upon such a doubtful subject, we should be disposed to regard the Leleges as a people of Pelasgian race, a portion of whom emigrated, at a very early period, from the continent of Greece to the islands of the Ægean Sea, where they became connected with the Carians, and subsequently joined them in their descent upon Asia Minor.

(Kruse's *Hellas:* Wachsmuth's *Historical Antiquities of the Greeks;* Thirlwall's *History of Greece; Philological Museum,* No. 1, art. "Ancæus.")

LEMMA (λῆμμα, literally "a thing taken or assumed"), a preparatory proposition borrowed from another subject, or from another part of the same subject, and introduced at the point at which it becomes indispensable. Thus, if in a treatise on mechanics it become necessary to prove certain propositions of geometry, those propositions are lemmas. Many writers use the term as if it applied to any necessary preliminary proposition: thus the seventh of the first book of Euclid is with them a lemma to the eighth. But this destroys the peculiar and ancient signification of the term, which it is desirable to retain, or else to avoid the word altogether.

LEMNISCATA, a curve (first noticed by James Bernoulli) having the form of an 8, but with the upper and lower parts perfectly symmetrical. It is the locus of the point in which a tangent to an equilateral hyperbola meets the perpendicular on it drawn from the centre. If the equation of the hyperbola be $x^2-y^2=a^2$, that of the lemniscata referred to the same axes is $(x^2+y^2)^2=a^2\,(x^2-y^2)$, and its polar equation is $r^2=a^2\cos.\,2\theta$. If the hyperbola be not equilateral, and its major and minor semi-axes be a and b, the locus above described is still a curve of the same form, and if

$$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$$

be the equation of the hyperbola, that of the new lemniscata is

$$(x^2+y^2)^2=a^2\,x^2-b^2y^2.$$

A great many different curves might be assigned, having the same form: an instance is $y^2=mx^2\,(a^2-x^2)$.

LEMONS, ACID OF. [CITRIC ACID.]

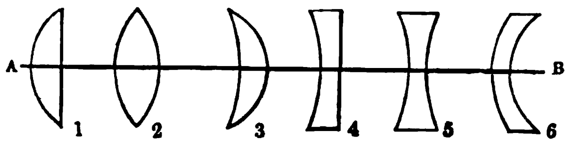
LEMONS, ESSENTIAL OIL OF. This well-known essence is extracted from the little cells visible on the rind of lemons, by submitting raspings of the fruit to pressure. It may also be obtained by distilling the peel with water, but the product is less agreeable although not so liable to undergo decomposition, owing to the absence of mucilaginous matter.

When pure, essential oil of lemons is colourless and limpid; specific gravity 0·847 at 70° Fahr.; boiling point about 145° Fahr.; soluble in all proportions in alcohol or ether. It is nearly all composed of a hydrocarbon, isomeric with oil of turpentine, CITREN or Citronyl, the boiling point of which is 329° Fahr., and specific gravity 0·857. An oxidised portion is also present, the composition of which has not been determined.

The greater portion of commercial oil of lemons is imported from Portugal and Italy, some however from France. It is very frequently adulterated with oil of turpentine.

LEMONS, SALT OF, a name improperly applied by druggists to binoxalate of potash. [OXALIC ACID.]

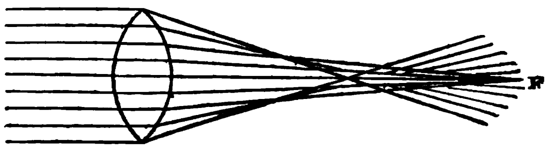
LENS (Latin for "a small bean"), a name given to a glass, or other transparent modium, ground with two spherical surfaces in such manner as to be generated by the revolution of one or other of the following figures about the axis A B.

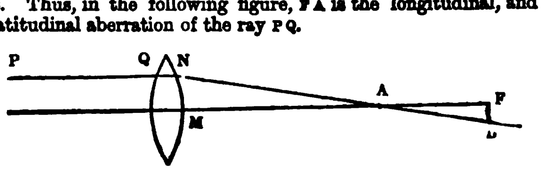


(1) is plano-convex; (2) is double-convex; when the radii are equal it is called equi-convex, and when one radius is 6 times the other it is called a crossed lens; (3) is a meniscus; in every such lens the concave side has the larger radius; (4) is plano-concave; (5) is double concave; (6) is concavo-convex.

We shall not here enter upon the laws of optics, but presuming them known, shall collect the principal facts and formulæ connected with the passage of a direct pencil of light, that is, of a pencil whose rays are either parallel to the axis, or converge to or diverge from a point in the axis. We shall follow the notation (for the most part) and formulæ of Mr. Coddington, in his standard work entitled 'A Treatise on the Reflexion and Refraction of Light,' Cambridge, 1829, which contains a most complete investigation of the subject; referring to the work itself for demonstration and extension.

The following figure represents the passage of a pencil of light with parallel rays through a double-convex lens. The rays are not all refracted to a point, but are tangents to a CAUSTIC, which has a cusp at a certain point F, and may be considered with sufficient accuracy as a small portion of a semicubical parabola. If however the aperture of the lens be no considerable portion of a sphere, which is always the case in practice, the rays which pass near the axis are thrown so thick about the point F, that the effect is an image of the extremely distant point from which the rays come, formed at F. This (for parallel rays) is called the focus of the glass, and its distance from the nearest side of the lens is called the focal distance. The longitudinal aberration of a ray is the distance from the focus at which it passes through the axis, and the latitudinal aberration is the perpendicular distance from the axis at which it passes through a perpendicular drawn through the focus. Thus, in the following figure, FA is the longitudinal, and FB the latitudinal aberration of the ray PQ.





We shall first state the method of finding the focal length of a given lens. Let μ be the index of refraction, or $\mu : 1$ the constant proportion which the sine of the angle of incidence bears to that of refraction (which for plate-glass varies from 1·500 to 1·540; for crown-glass, from 1·525 to 1·563; and for flint-glass from 1·576 to 1·642); and let R and S be the radii of the two sides of the lens *with their signs*, while r and s are the numerical values of these radii independently of their signs. Also let every convex surface be considered as having a positive radius, and every concave surface a negative one. Let F be the focal distance with its sign, and f the numerical value of the same, it being agreed that the focal distance shall be positive when parallel rays are made to converge, and negative when they are made to diverge, that is, to proceed as if they came from a point on the same side of the glass as that on which they entered. One formula, upon these suppositions, will embrace all the cases; and that formula is

$$\frac{1}{F} = (\mu-1)\left(\frac{1}{R} + \frac{1}{S}\right)$$

on the supposition that the central thickness of the lens is inconsiderable. But if this thickness, though small, be large enough to render it necessary to take it into account, let the thickness be called t, and let R be the radius of the side at which the light enters: then either find F from

$$\frac{1}{F} = (\mu-1)\left(\frac{1}{R} + \frac{1}{S}\right) + \frac{(\mu-1)^2}{\mu} \cdot \frac{t}{R^2};$$

or correct F, as found from the preceding formula, by subtracting from its *algebraical* value

$$\frac{(\mu-1)^2}{\mu} \frac{F^2 t}{R^2}$$

F being found from the preceding: the result is sufficiently correct.

The focal distance, as determined from the first formula, is the same whether the light enter on one side or the other, but the correction for the thickness depends, as we see, upon the side at which it enters.

The application of these formulæ to the several cases is as follows:— We write the distinctive adjective of the lens so that the first part of the word shall denote the part at which light first enters; for instance, plano-convex, or convexo-plane, according as the light first meets the plane or convex surface.

(1). *Plano-convex:* R is infinite, $S=s$.

$$\frac{1}{F} = \frac{\mu-1}{S}, \text{ or } f = \frac{s}{\mu-1}.$$

(1). *Convexo-plane:* $R=r$, and S is infinite:

$$\frac{1}{F} = \frac{\mu-1}{R} + \frac{(\mu-1)^2 t}{\mu R^2} : f = \frac{r}{\mu-1} - \frac{t}{\mu}.^*$$

(2). *Double-convex:* $R=r$, $S=s$:

$$\frac{1}{f} = (\mu-1)\left(\frac{1}{r} + \frac{1}{s}\right) + \frac{(\mu-1)^2}{\mu} \frac{t}{r^2}.$$

(3). *Convexo-concave meniscus:* $R=r$, $S=-s$, $r<s$:

$$\frac{1}{F} = (\mu-1)\left(\frac{1}{r} - \frac{1}{s}\right) + \frac{(\mu-1)^2}{\mu} \frac{t}{r^2} = \frac{1}{f}.$$

(3). *Concavo-convex meniscus:* $R=-r$, $S=s$, $r>s$:

$$\frac{1}{F} = (\mu-1)\left(\frac{1}{s} - \frac{1}{r}\right) + \frac{(\mu-1)^2}{\mu} \frac{t}{r^2} = \frac{1}{f}.$$

In all the preceding cases F is positive; or all sharp-edged lenses make parallel rays converge: but in those which follow it will be noted that F is negative, or all flat-edged lenses make parallel rays diverge.

(4). *Plano-concave:* R is infinite, $S = -s$:

$$\frac{1}{F} = -\frac{\mu-1}{s}, \text{ or } f = \frac{s}{\mu-1}.$$

(4). *Concavo-plane:* $R = -r$, S is infinite:

$$\frac{1}{F} = -\frac{\mu-1}{r} + \frac{(\mu-1)^2}{\mu} \frac{t}{r^2} : f = \frac{r}{\mu-1} + \frac{t}{\mu}.^*$$

(5). *Double-concave:* $R = -r$, $S = -s$:

$$\frac{1}{F} = -(\mu-1)\left(\frac{1}{r} + \frac{1}{s}\right) + \frac{(\mu-1)^2}{\mu} \frac{t}{r^2};$$

$$\frac{1}{f} = (\mu-1)\left(\frac{1}{r} + \frac{1}{s}\right) - \frac{(\mu-1)^2}{\mu} \frac{t}{r^2}.$$

(6). *Convexo-concave:* $R=r$, $S= -s$, $r>s$:

$$\frac{1}{F} = (\mu-1)\left(\frac{1}{r} - \frac{1}{s}\right) + \frac{(\mu-1)^2}{\mu} \frac{t}{r^2};$$

$$\frac{1}{f} = (\mu-1)\left(\frac{1}{s} - \frac{1}{r}\right) - \frac{(\mu-1)^2}{\mu} \frac{t}{s^2}.$$

(6). *Concavo-convex:* $R= -r$, $S=s$, $r<s$:

$$\frac{1}{F} = (\mu-1)\left(\frac{1}{s} - \frac{1}{r}\right) + \frac{(\mu-1)^2}{\mu} \frac{t}{r^2};$$

$$\frac{1}{f} = (\mu-1)\left(\frac{1}{r} - \frac{1}{s}\right) - \frac{(\mu-1)^2}{\mu} \frac{t}{r^2}.$$

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* These results are only nearly true.

If, in any of the preceding, the term involving t be left out, we have the common approximate mode of determining the focus. We now come to the formulæ for determining the aberration in the case of a direct pencil of parallel rays.

Let M N, in the third figure (the perpendicular distance from N to the axis will do equally well) be $=y$; then A F is determined by the following formula :—

$$K = -\frac{\mu-1}{2\mu^2}\left\{\frac{1}{R^3}+\left(\frac{1}{S}+\frac{\mu+1}{F}\right)\left(\frac{1}{S}+\frac{1}{F}\right)^2\right\}F^2y^2$$

where R is the radius of the surface which the light first meets. The algebraical value of M A in the figure is F + K, where F is supposed corrected for the thickness. If we assume

$$X=\frac{S-R}{S+R};\ \text{then } K=-\frac{A\,y^2}{8\,F};$$

where A stands for

$$\frac{1}{\mu(\mu-1)}\left\{\begin{matrix}\dfrac{\mu+2}{\mu-1}X^2-4(\mu+1)X\\[2ex] +(3\mu+2)(\mu-1)+\dfrac{\mu^3}{\mu-1}\end{matrix}\right\}$$

The following are the results, assuming $\mu=\frac{3}{2}$, which is near enough (if the material be glass) for determining this correction. This supposition gives (x being the numerical value of X, independently of sign)

$$K=-\frac{7X^2-10X+10}{6}\cdot\frac{y^2}{F}.$$

(1). *Plano-convex :* $X=-1\ K=-\frac{9}{2}\frac{y^2}{F}$.

(1). *Convexo-plane :* $X=1$. $K=-\frac{7}{6}\frac{y^2}{F}$.

(2). *Double-convex* : light entering at the more convex side :

$$x=\frac{s-r}{s+r},\ K=-\frac{7x^2-10x+10}{6}\frac{y^2}{F}.$$

(2). *Double-convex :* light entering at the less convex side :

$$x=\frac{r-s}{r+s},\ K=-\frac{7x^2+10x+10}{6}\frac{y^2}{F}.$$

(3). *Convexo-concave meniscus :*

$$x=\frac{s+r}{s-r},\ K=-\frac{7x^2-10x+10}{6}\frac{y^2}{F}.$$

(3). *Concavo-convex meniscus :*

$$x=\frac{r+s}{r-s},\ K=-\frac{7x^2+10x+10}{6}\frac{y^2}{F}.$$

(4). *Plano-concave :* same [*] as plano-convex.

(4). *Concavo-plane :* same as convexo-plane.

(5). *Double concave,* light entering at the more concave side : same as double convex, light entering at the more convex side.

(5). *Double concave,* light entering at the less concave side : same as double convex, light entering at the less convex side.

(6). *Convexo-concave :* same as concavo-convex meniscus.

(6). *Concavo-convex :* same as convexo-concave meniscus.

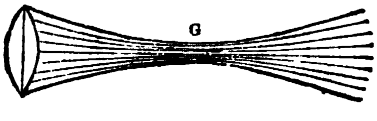
Throughout these formulæ the sign of K is opposite to that of F, since $7x^2 \pm 10x + 10$ must always be positive. Hence the point A always lies between the points M and F (third figure). If the point N be placed as high as possible, that is, if y be what is called the *semi-aperture* of the lens, then K ir the aberration of the extreme ray. It appears also that the longitudinal aberration varies directly as the square of the semi-aperture, and inversely as the focal distance.

The aberration is least for a given aperture and focal length, when $x=\frac{5}{7}$, which gives $S=6R$, requiring a double-convex or double-concave lens, in which the radius of the side on which light enters is one-sixth of the other. The convex lens of this kind is what opticians call the crossed lens. The co-efficient of $y^2 \div F$ is $-\frac{15}{14}$.

The latitudinal aberration at the focus (as determined with the correction for the thickness) is $y\,K \div F$, or (neglecting the sign)

$$\frac{1}{8}\,A\,\frac{y^3}{F^2};\ \text{for glass } \frac{7X^2-10X+10}{6}\,\frac{y^3}{F^2}.$$

But if we observe the rays in the second figure (and the same may be clearly seen in a beam of sun-light thrown into an otherwise dark room through a convex lens) we shall see that the luminous space is bounded by a surface of revolution which narrows and afterwards spreads again, as in this diagram. The smallest circle (at G) is called the circle of least aberration, and is determined as follows :—Its centre is nearer to the glass than the focus (corrected for the thickness) by three-fourths of the longitudinal aberration of the extreme ray; and its diameter is one-half of the lateral aberration of the extreme ray. If then we measure from the corrected focus, we find for the distance of the circle of least aberration (neglecting its sign) from this focus,



$$\frac{3\,A\,y^2}{32\,F};\ \text{for glass } \frac{7X^2-10X+10}{8}\cdot\frac{y^2}{F};$$

and for the diameter of this circle,

$$\frac{A\,y^3}{16\,F^2},\ \text{for glass } \frac{7X^2-10X+10}{12}\,\frac{y^3}{F^2}.$$

The correction for the thickness, to be subtracted from F as determined by the first equation of all, is

$$-\frac{1}{4\mu}(X+1)^2.t;\ \text{for glass} -\frac{1}{6}(X+1)^2.t;$$

which is always algebraically subtractive, whatever the sign of F may be. The following table exhibits this correction, the distance of the circle of least aberration, and its diameter, for the cases above noted. The description of the lens is in the first column, and I stands for plane (or plano), C for concave, and inverted C for convex. The sign of the surface which the light first meets is placed first. Where a great and small letter meet, the small letter shows the side which has the less curvature, or the larger radius.

$$\alpha = 7x^2 - 10x + 10$$
$$\beta = 7x^2 + 10x + 10$$

Lens.	X or x.	Correction for thickness.	Distance of Circle.	Diameter of Circle.
IƆ and IC	$X=-1$	0	$\frac{27}{8}\ \frac{y^2}{F}$	$\frac{9}{4}\ \frac{y^2}{F^2}$
CI and ƆI	$x=1$	$\frac{2}{3}t$	$\frac{7}{8}\ \frac{y^2}{F}$	$\frac{7}{12}\ \frac{y^3}{F^2}$
Cɔ and Ɔc	$x=\frac{s-r}{s+r}$	$(x+1)^2\frac{t}{6}$	$\frac{\alpha}{8}\ \frac{y^2}{F}$	$\frac{\alpha}{12}\ \frac{y^3}{F^2}$
cƆ and ɔC	$x=\frac{r-s}{r+s}$	$(x-1)^2\frac{t}{6}$	$\frac{\beta}{8}\ \frac{y^2}{F}$	$\frac{\beta}{12}\ \frac{y^3}{F^2}$
Cc and Ɔɔ	$x=\frac{s+r}{s-r}$	$(x+1)^2\frac{t}{6}$	$\frac{\alpha}{8}\ \frac{y^2}{F}$	$\frac{\alpha}{12}\ \frac{y^3}{F^2}$
ɔƆ and Cc	$x=\frac{r+s}{r-s}$	$(x-1)^2\frac{t}{6}$	$\frac{\beta}{8}\ \frac{y^2}{F}$	$\frac{\beta}{12}\ \frac{y^3}{F^2}$

We have judged it more useful to collect what we may call the *critical* formulæ, by which the fitness of a lens for any given purpose may be estimated, than to enter upon explanations of optical principles in an isolated article. We shall now give the formulæ only, omitting the detail of cases, when the pencil of rays is not parallel, but proceeds from a point in the axis.

Let U be the distance of the focus of the entering pencil from the surface whose radius is R, and V the distance of the focus of the rays on the other side from the surface whose radius is S; U being negative when the entering pencil is convergent, and V negative when the emergent pencil is divergent. Let F be the distance of the uncorrected focus of parallel rays from the surface of emergence, determined as before. Then, if the thickness of the lens be inconsiderable, V is determined from U by the equation,

$$\frac{1}{V}+\frac{1}{U}=\frac{1}{F}=(\mu-1)\left(\frac{1}{R}+\frac{1}{S}\right);$$

V representing the solution of this equation, the more correct value, taking the thickness t into account, is

$$V-\left(\frac{\mu-1}{R}-\frac{1}{U}\right)^2\frac{t\,V^2}{\mu},$$

$$\text{Let } X=\frac{S-R}{S+R};\ W=\frac{V-U}{V+U};$$

then the above correction for the thickness is

$$V-\left(\frac{X-W}{1-W}\right)^2.\ \frac{t}{\mu}:$$

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[*] That is, the aberration has the same formula : but it must be noted that F has different signs in the two lenses.

and assuming A to stand for

$$\frac{1}{\mu(\mu-1)}\left\{\begin{array}{l}\frac{\mu+2}{\mu-1}X^2+4(\mu+1)WX\\ +(3\mu+2)(\mu-1)W^2+\frac{\mu^3}{\mu-1}\end{array}\right\}$$

the longitudinal aberration is

$$-\frac{A}{8}\frac{V^2}{F^2}\frac{y^2}{F};\ \text{or}-\frac{A}{2(1-W)^2}\cdot\frac{y^2}{F};$$

which must be algebraically applied to the value of V (corrected for thickness). The latitudinal aberration is

$$\frac{A}{8}\frac{V}{F}\frac{y^3}{F^2};\ \text{or}\ \frac{3A}{4(1-W)}\cdot\frac{y^3}{F^2}.$$

The distance of the least circle of aberration from the corrected focus is

$$-\frac{3A}{32}\frac{V^2}{F^2}\cdot\frac{y^2}{F};\ \text{or}-\frac{A}{8(1-W)^2}\cdot\frac{y^2}{F};$$

and the diameter of the same circle is

$$\frac{A}{16}\frac{V}{F}\frac{y^3}{F^2};\ \text{or}\ \frac{A}{8(1-W)}\frac{y^3}{F^2}.$$

When two or more lenses are placed close together, in finding the approximate focal distance, uncorrected for the thicknesses, they may be considered as one lens, whose focal distance has a reciprocal equal to the sum of the reciprocals of the focal distances of the component lenses. Sir J. Herschel has proposed to call the reciprocal of the focal distance the *power* of a lens; in which case it would be said that the power of a compound lens is equal to the sum of the powers of the simple lenses.

For more complicated cases, see the work of Mr. Coddington, already cited.

Hitherto we have supposed the surfaces of the lens to be either plane or spherical, as is usually the case. Lenses are, however, sometimes made with cylindrical surfaces. If the two surfaces of a thin lens are portions of cylinders of equal radii, with their axes perpendicular to each other, and both surfaces are convex or both concave, the lens will have the same general effect as an equi-convex or equi-concave lens, the radius of the spherical surfaces of which is double that of the cylindrical surfaces of the former lens. Such cylindrical lenses may sometimes be advantageously employed instead of spherical lenses. Thus, when a large lens is held at some distance from the eye, and used for viewing an engraving or photograph, the distortion with a cylindrical lens is of a less unpleasant character than with a spherical lens.

But there is a further use of lenses with one or both surfaces cylindrical in correcting a defect of the eye, by no means uncommon, which consists in the length of sight being, so to speak, different in different planes passing through the axis of the eye, and which sometimes is so great as to cause very serious inconvenience. Its existence is known by directing the eye to the clouds, and holding a small needle-hole in a blackened card at first close to the eye, and then moving it off to arm's length, the eye all the while being adapted for vision of a distant object. The indistinct mirage of the hole ought to remain circular at all distances; but when this defect exists, the mirage passes successively into two lines in rectangular directions, unless the eye be too long-sighted, in which case the lines are seen by adapting it to vision of a nearer object, or if that be not enough, using an ordinary convex lens. The defect, when it exists, may be corrected by means of spectacles having one surface at least of the lens for the defective eye cylindrical. See papers in the 'Cambridge Philosophical Transactions,' vol. 2, p. 267, and vol. 8, p. 493; also 'Report of the British Association' for 1849, p. 10.

LENT (in Latin, *Quadragesima*), a time of mortification, commemorative of the miraculous fasting of our Saviour in the Desert; used as a preparation for Easter, and beginning on Ash Wednesday. The Saxon term was *Lencten*, implying Spring, the season when the day increases in *length*, about the commencement of which this fast, which is a moveable one, usually falls: it is in fact the Spring-Fast.

In the ancient Latin Church, Lent consisted only of thirty-six days: the four additional days were added by Pope Gregory in the 9th century.

Some assert that this fast was first instituted by the Apostles. Such was the opinion of St. Jerome, St. Leo, St. Augustine, and others. Tertullian speaks of it as of long standing in his time: though some writers date it as low as the 3rd century. It was first observed in England by our Saxon ancestors in 640, by order of Ercombert, King of Kent.

(Wheatley *On the Common Prayer*, 8vo, London, 1741; Brady's *Clavis Calendaria*.)

LENTO (Ital., *slowly*), a term in music equivalent to *Largo*.

LEO (the Lion), a constellation of the ZODIAC, which commemorates the Nemæan lion killed by Hercules in the mythology of the Greeks. It is surrounded by Ursa Major, Leo Minor, Cancer, Hydra, Sextans, Virgo, and Coma Berenices. A line drawn through the pole star and the lowest of the four in the Great Bear (or γ) passes through Deneb (or β Leonis); and a line drawn through the bright star Regulus (or α Leonis) of the first magnitude and Deneb passes nearly through Arcturus. The principal stars are as follows:—

Character.	No in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
λ	4	3246	4
ο	14	3312	3½
ε	17	3331	3
μ	24	3371	3
η	30	3453	3
α	32	3459	1
ζ	36	3508	3
γ	41	3523	2
ρ	47	3609	4
δ	68	3834	2½
θ	70	3838	3
φ	74	3848	4
ι	78	3877	4
τ	84	3900	4
	93	3990	4
β	94	3995	1½

LEO MINOR, a constellation of Hevelius, surrounded by Ursa Major, Lynx, Cancer, and Leo. Its principal stars are as follows:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
b	10	3261	4½
f	30	3560	4¾
n	42	3685	4½
o	46	3728	4½

LEONINE VERSES, a kind of measure much in fashion during the middle ages. It consists properly of the Latin hexameter, or hexameter and pentameter rhymed. No less than ten varieties in the fall of the rhymes are counted; but that which is by far the most common is when the cæsura on the fifth syllable rhymes with the end of the line, as for example:—

> "En Rex Edvardus, debacchans ut Leopardus."

There is an example of a modern attempt at Leonine verses in Parnell's translation of a passage in the 'Rape of the Lock,' beginning,

> "Et nunc dilectum speculum pro more retectum."

The rhymes appear universally to be dissyllabic. The classical metre is however not essential. We find in the ancient hymns of the Roman Catholic Church the rhythm of modern versification:—

> "Quid sum miser tunc dicturus,
> Quem patronum rogaturus,
> Cum vix justus sit securus?"

Or in the famous song of Walter de Mapes, archdeacon of Oxford in the time of Henry II.:—

> "Mihi est propositum in taberna mori,
> Vinum sit appositum morientis ori,
> Ut dicant, cum venerint Angelorum chori,
> Deus sit propitius huic potatori."

The term is said to be derived from Leoninus, a monk of the 12th century, the reputed inventor of this mode of composition, which however is shown to go back as far at least as the 3rd century. It went out of fashion with the revival of classical learning.

LEPIDINE. [LEUCOLINE.]

LEPRA (the Greek word λέπρα, scaliness), an affection of the skin, of the order Squamæ, or scaly diseases, of Willan and Bateman. It is characterised by an eruption of circular spots of inflamed skin covered with scales, varying from the size of a pin's head to that of a shilling or even a half-crown piece, occasionally mixed with large irregular patches formed by the coalescing of the borders of several contiguous spots. The scales in this affection possess a peculiar character, by which it is distinguished from pityriasis and psoriasis, other diseases of the same order. From the surface of the inflamed spots a diseased cuticle is produced, which concretes into thickish crusts or scales of a glistening white silvery appearance, and from being secreted more abundantly towards the circumference a rounded and elevated form is given to the outer margin, whilst the centre is left almost or entirely free from scale. The whole is surrounded by a slight areola of redness. In the early stage of the disease, and in the small spots, the inflamed skin, which is slightly raised above the surrounding parts, possesses only a thin scaly covering; and in the larger patches, formed by the coalescence of several spots, the characteristic appearances become somewhat confused; still, on careful examination, the elevated margin, circular outline, and central free spot may more or less be recognised.

This disease generally affects young people from the age of puberty up to thirty, and appears to occur more frequently in women than in men. Sometimes the whole body becomes affected by it, even the face and scalp, but more commonly it is confined to the limbs, and is observed especially on the skin below the knee and elbow, in which situations its true characters are generally most marked. The health of persons affected with this disease is but little disturbed, the accession of the eruption alone being preceded by headache and slight febrile disturbance. It is generally tedious of cure, recurring periodically in some constitutions, whilst in others it will continue for two or three years. Most frequently it arises without any assignable cause; occasionally it has appeared to be dependent upon suddenly suppressed cutaneous transpiration from persons drinking cold water when overheated.

This disease must not be confounded with the leprosy of the sacred and ancient writers, a term which appears to have been used to express any loathsome affection of the skin, or, as some imagine, to have referred to the disease described in the present day under the term Elephantiasis. [Elephantiasis.]

The treatment of lepra should consist in the administration of alterative and depurative medicines. Gentle purgatives, iodide of potassium, arsenic, quinine, and iron, may be given according to circumstances. Externally, the preparations of tar and creasote have been found of most benefit.

LEPROSY. [Lepra; Skin, Diseases of the.]

LEPUS (the Hare), one of the old constellations, said by Hyginus to be in the act of running from Orion's dog, which is the greater dog, according to some, and the lesser, according to others. It is situated directly under Orion. The principal stars are as follows:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
ε	2	1575	4
β	9	1715	3
α	11	1741	3
γ	13	1823	3
ζ	14	1840	4
δ	15	1871	3½
η	16	1901	4
θ	18	1959	4

LETHARGY, a state of unnaturally deep and prolonged sleep, a condition intermediate between the sleep of health and complete coma. If not the result of unusual fatigue, it is often an alarming symptom, indicating congestion of the brain, and a disposition to apoplexy, or even an impending attack of that disease. [Apoplexy; Coma; Sleep.]

LETTER OF CREDIT. [Credit, Letter of.]

LETTER or POWER OF ATTORNEY is an instrument by which one person authorises another to do some act for him; it may be used in any lawful transaction, as to execute a deed, to collect rents or debts, to sell estates, &c. The authority must be strictly pursued, for the principal is only bound by the acts of his agent to the extent to which the letter of attorney authorises him to proceed, and if the agent goes beyond his authority he is personally liable to the party with whom he contracts. The power authorising an attorney or agent to do some particular act impliedly includes an authority to do whatever is incident to that act; as for instance, a power to demand and recover a debt authorises the arrest of the debtor in all cases where it is permitted by law. But a power to receive money and to give releases, or even to transact all business, does not authorise the attorney to negotiate bills received in payment. In fact all written powers, such as letters of attorney or letters of instruction, receive a strict interpretation; the authority never being extended beyond that which is given in terms, or is absolutely necessary for carrying the authority so given into effect. An attorney, unless power be specially given him for that purpose, cannot delegate his authority or appoint a substitute, and, generally speaking, the words of general authority usually inserted in letters of attorney, after giving the particular authority, do not enlarge it.

The authority must be executed during the life of the person who gives it, as the act done is considered to be in every respect his act, and a power to do an act is therefore considered as at once revoked by the death of the person giving it.

Powers of attorney may be given either in separate instruments, or in deeds relating to other matters; the second form is usually followed where the instrument forms part of a security for money, as where a chose in action is assigned either as a security for money or to an actual purchaser. The deed of assignment contains a power of attorney authorising the assignee to sue in the name of the assignor. Powers of attorney are generally executed under hand and seal, and where they contain an authority to bind the principal by *deed*, it is essential that they should be so executed. When the agent signs any instrument which is to bind his principal, he must sign it in the name of the principal, and not in his own name.

A power of attorney, unless it be given as a security, is revocable at pleasure, either by the personal interference of the principal or by his granting a new power to another person. But if the power has been given as a security, or as it is sometimes called, is coupled with an interest, it is not revocable. Though it has been decided that a power of attorney coupled with an interest is revoked by the death of the grantor, yet if it authorise the agent to act in the name of the grantor, his executors, &c., it may be held that such a power, when given as part of a security, is not revoked by the death of the principal, and that the assignee of his interest has power to do the acts necessary to render his security available in a court of law, in the name of the representatives of the assignor. At all events a court of equity would interfere in favour of the assignee.

A letter of attorney is also in general revoked by the bankruptcy of the principal, unless it is coupled with an interest.

LETTERS-PATENT (in Law), the king's letters, sealed with the great seal. These grants, says Blackstone (2 'Comment.' p. 349, Mr. Kerr's Ed.), whether of lands, honours, liberties, franchises, or anything else that can be granted, are contained in charters or letters-patent, that is, open letters, *literæ-patentes*. They are so called because they are not sealed up, but open to view, with the great seal pendant at the bottom, and are usually directed or addressed by the king to all his subjects at large. Letters-patent, in the time of Queen Elizabeth, as well as in several preceding reigns, were not unusually obtained for purposes of mere monopoly.

They are now frequently granted under the royal authority as the reward of ingenuity, and are in some cases the only means by which a man can secure any compensation for a discovery, or for the labour and expense which he may have employed in perfecting an invention. The consideration of the legal rights of patentees, and of the modes in which they may be acquired and secured, properly belongs to the head of Patents. At present it may be sufficient to refer the reader to Collier's 'Essay on the Law of Patents for New Inventions, to which are prefixed two chapters on the general history of monopolies, and on their introduction and progress in England to the time of the Interregnum,' 8vo., Lond., 1803; to Hand's 'Law and Practice of Patents for Inventions,' 8vo., Lond., 1808; Godson's 'Practical Treatise on the Law of Patents,' 8vo., Lond., 1823, with the 'Supplement,' 8vo., Lond., 1832; and Rankin's 'Analysis of the Law of Patents,' 8vo., Lond., 1824. The Patent Law Amendment Act 1852, now regulates the terms upon which letters patent for inventions are granted. See Mr. Kerr's 'Blackstone,' vol. 2, p. 417.

Many letters-patent have been granted by the king to the founders of schools and other charitable endowments, empowering the donor to make rules and ordinances for the government of his charity, and constituting into a body corporate those persons and their successors whom the founder should choose or nominate.

LETTERS, THREATENING. [Threats.]

LETTUCE (the *Lactúca sativa*, or garden lettuce) is one of the principal kinds of vegetables used for salads, and it also forms an ingredient in several kinds of soup. It has been introduced and cultivated in this country for nearly three centuries, but, like many other domesticated plants, its origin is unknown. The names of several of its varieties indicate their having come to us from the Greek Archipelago and the coast of the Levant; and one of the two divisions into which the numerous varieties of lettuces are usually classed, termed *Cos lettuces*, derives its name from the island of Cos, the modern Stanco. This division includes those of an erect oblong form of growth. The other division, which comprehends those of a roundish, flattened, or spreading form, is termed that of *Cabbage lettuces*.

The excellence of lettuces consists in their being crisp and tender; their growth should therefore be so conducted as to sustain no check or interruption. If their quick vegetation be stopped by such causes as excessive drought, over-crowding in the seed-bed, or improper transplanting, they will in consequence either run to seed or become tough, and their juices at the same time will acquire an acrid quality.

The ground intended for the seed should be fresh dug, rich, and mellow. The principal summer crop should be sown in March and April, and the seed lightly covered. A seed bed 4 ft. by 10 ft. will require a quarter of an ounce of seed, which ought to produce about 400 plants. If the plants are intended to attain their full perfection where sown, they must be thinned out to distances of 9 inches square, in the case of the small cabbage varieties, and the larger sorts should be allowed at least a foot each way. In transplanting, the above distances are likewise applicable and the operation should be performed, if possible, in cloudy weather; but at all events it must be done before the plants are too old or are in the least over-crowded; for when they are drawn, or their stems have once commenced lengthening, which, in dry weather, will sometimes happen whilst they are yet in a small state, it is useless to transplant them. It is of importance that the soil in which they are grown be neither too wet nor too dry. Where the breadth to be planted is not so great as to render the expense of labour an object of consideration, instead of making holes for the plants with a dipper, it is better to form a small trench, with a perpendicular cut next the line, against which the roots are to be disposed without bruising. Water should be given, but not at any one time to excess; nor merely at the root of each plant, but over the whole of the ground.

The Cos lettuces require to have their leaves tied together moderately close, with a strip of matting, for the purpose of assisting their blanch-ing and rendering them more crisp and delicate. This should be done about a week previous to their attaining full perfection. The Paris Cove Cos requires least assistance in this way, because the tops of its leaves are concave, and successively apply themselves closely to each other. To obtain a constant supply, successive sowings are requisite to be made from February to July for the summer crop. Those plants intended to stand the winter should be sown in the end of August or beginning of September; and when fit, should be transplanted to the bottom of walls or other fences having a south aspect, or to the sides of slopes or ridges, made for the purpose, over which a protection of mats, supported on hoops, may be formed. When the demand is such as to require greater security, recourse must be had to frames or pits. The first full supply from the open ground is best obtained by sowing under glass on a decayed hot-bed in the second week in October. When the plants come up they should be regularly thinned. Abundance of air should be admitted when the state of the weather will permit, and when mild the plants should be fully exposed; but the slightest frost should be guarded against. Very little water will be required; in fact the effects of damp are to be dreaded, and therefore every favourable opportunity should be taken for the admission of air, provided it is not saturated with moisture, unless when too low a temperature would render such a proceeding injudicious. A full exposure to air, both night and day, is necessary for some time previous to planting out in the open ground, which operation may take place in February, if the weather then prove favourable. A reserve should be kept in the frames in case of severe frost occurring after the plantation has been made.

LEUCIC ACID. [LEUCIN.]

LEUCIN ($C_{12}H_{13}NO_4$) *Aposepidin.* Leucin is a white crystalline substance frequently met with in chemical operations upon animal substances. Its composition and properties indicate that it is homologous with sugar of gelatin [GLYCOCOLL], and with ALANIN, as seen from the following formulæ:—

Glycocoll	$C_4H_5NO_4$
Alanin	$C_6H_7NO_4$
Leucin	$C_{12}H_{13}NO_4$

Gerhardt considered it as a hydrocyanic acid derivative of hydride of valeryl, formed as follows:—

$$\underbrace{C_{10}H_{10}O_2}_{\text{Hydride of valeryl.}} + \underbrace{C_2HN}_{\text{Hydrocyanic acid.}} + \underbrace{HO}_{\text{Water.}} = \underbrace{C_{12}H_{13}NO_4}_{\text{Leucin.}}$$

Limpricht has, in fact, within the last few years obtained leucin by the action of hydrochloric and hydrocyanic acids upon valeride of ammonium.

Leucin is a product of the putrefaction of cheese and of gluten in the presence of water; also of the action of sulphuric acid, or hydrate of potash upon muscular flesh, wool, white of egg, gelatin, horn, &c.

The preparation of pure leucin is a somewhat tedious operation. The simplest process is that adopted by Mulder; it consists in boiling albumen, gelatin, or fibrin, with caustic potash until decomposition is evidently complete, evaporating the liquor to dryness, extracting the residue with alcohol, and evaporating the filtered liquid, that the leucin may crystallise out. It is finally purified by repeated recrystallisation from alcohol.

Pure leucin occurs in soft, light, colourless plates, somewhat resembling cholesterin. It is slightly soluble in cold but readily so in hot water. In alcohol it is not very soluble, and in ether it is insoluble. Heated to 338° Fahr., it sublimes without melting and without decomposition, and condenses in beautiful silky flocks. Fused with hydrate of potash, it is decomposed into valeric acid, ammonia and hydrogen being evolved.

One equivalent of hydrogen in leucin may be replaced by copper, mercury, &c., and compounds formed soluble in water and deposited on evaporation in a granular or lamellar form. The copper compound contains ($C_{12}H_{12}Cu\,NO_4$); the mercuric combination ($C_{12}H_{12}Hg\,NO_4$).

Leucin is easily dissolved by the dilute acids, combining with them to form bodies that crystallise out on evaporation. The ***nitrate of leucin***, sometimes called *nitroleucic acid*, has the formula ($C_{12}H_{13}NO_4$, $HO\,NO_5$); it crystallises in colourless needles. The ***hydrochlorate*** and the ***sulphate*** are also crystalline.

Leucic acid.—When binoxide of nitrogen is passed into a solution of leucin in nitric acid, nitrogen is evolved and an oily body obtained, to which the name of leucic acid has been given. It is very soluble in ether, gives crystallisable salts with bases, and is homologous with lactic acid.

LEUCOL. [LEUCOLINE.]

LEUCOLINE, *Leucol, Quinoline* ($C_{18}H_7N$), is one of the compounds found in the least volatile portions of the basic oil of coal-tar. It is also formed when quinine, cinchonine, or strychnine are heated in contact with potash. It is a liquid with a disagreeable smell, and boiling at the temperature of 460°. It neutralises acids, and forms with them salts.

Greville Williams has recently shown that the substance to which the names leucoline and quinoline have been given is a mixture of two homologous bases—namely, quinoline ($C_{18}H_7N$), and lepidine ($C_{20}H_9N$).

LEUCO'MA, a white opacity of the cornea. [EYE: NAT. HIST. DIV.] It is the result of acute inflammation producing a deposition of lymph on the surface and in the layers of the cornea, either with or without ulceration of its substance. In those cases in which there is merely an effusion of lymph on the surface, or between the superficial layers of the membrane, it is often re-absorbed on the cessation of the inflammation, and the cornea recovers its transparency. But when the disease is more extensive and more deeply seated, the probability of recovery is far less, and many such cases are incurable by any means at present known. The most efficient mode of treatment is that with astringent lotions, such as a solution of nitrate of silver, in the proportion of from one to five grains to the ounce of distilled water.

LEUCORCEIN. [LICHENS, COLOURING MATTER OF.]

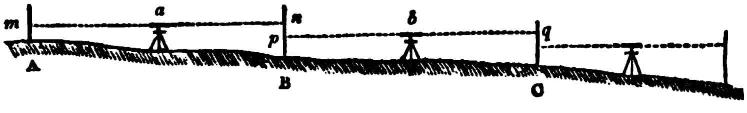
LEUCOTURIC ACID. [URIC ACID.]

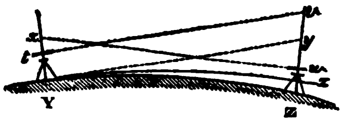
LEVELLING is the art of determining the heights or depressions of points on the ground with respect to a spherical or spheroidal surface coinciding nearly with that of the earth, or, when the extent of ground is inconsiderable, with respect to a horizontal plane passing through some given point on the ground.

In extensive operations of this nature, which are connected with the researches of physical astronomy, an attention to that figure of the earth which approaches the nearest to the truth is of importance; but when the object is merely to determine the profile of the ground, for a canal, or a line of road, it is sufficient to consider the surface to which the points are referred as that of a sphere.

The relative heights of a series of points on the ground are obtained by means of their vertical distances from others which, on the supposition of the earth being a sphere, are equally distant from its centre; and these, which are called level-points, must be found by an instrument constructed for the purpose. Now, a plane being supposed to touch the earth at any given point, all the points in the circumference of a circle described on that plane, about that point of contact as a centre, will be level-points: consequently, if a telescope be so adjusted that, when turned round upon the vertical axis of the instrument to which it is applied, its line of collimation (that which passes through the centres of all the lenses) may remain parallel to the horizon, any number of such level-points will be determined, if, being at equal distances from the said axis, they are in the direction of the line of collimation produced. The instrument alluded to is called a spirit-level [SPIRIT LEVEL; THEODOLITE]; and by certain adjusting screws the line of collimation, or optical axis of the telescope, is capable of being brought into the position above mentioned, which is indicated by a bubble of air remaining, during a complete revolution of the telescope, in the middle of the tube containing the water or spirit.

The instrument is employed for the purpose of ascertaining the relative heights of points on the ground in either of the following ways, the first of which is the most simple, and is frequently adopted. Choice is made of any convenient stations, A, B, &c., on the line of operation, and the distances between them are determined either by actual admeasurement, or by computations founded on the data afforded by a previous survey of the ground. The instrument is then set up at, or near, the middle of the interval between every two such points in succession. When the telescope thus placed, as at *a*, has been rendered horizontal by means of the adjusting screws, an assistant at each of the stations A and B, holding what is called a station staff in a vertical position, moves a vane or index along the staff, upwards or downwards, according to the directions of the observer at the telescope, till it appears to coincide with the intersection of two wires in the telescope, that intersection having, by the adjustment of the instrument, been made to coincide with the optical axis, or line of collimation.





The points thus determined on the staves are represented by *m* and *n*; and, from what has been said, these are level-points, or points equally distant from the centre of the earth. Therefore, the heights A*m* and B*n* being read on the graduated staves, the difference between them will give the relative heights of the ground at A and B; that point, of course, being the highest at which the distance of the vane from the ground is the least. A similar process is repeated with respect to the points B and C, the instrument being placed at *b*, midway between them; and the operation is to be continued to the end of the line on which the profile is required. It is customary to insert the heights B *n*, C *q*, &c., in a column headed *Fore-sights*, in a sort of field-book, and the heights A *m*, B *p*, &c., in a collateral column headed *Back-sights*. The difference between the sums of the numbers in these two columns will be equal to the height of one extremity of the line above the other.

But it is very generally the practice, with the view of diminishing the risk of error arising from the imperfection of the instrument, to execute a sort of double levelling. This consists in placing the spirit-level successively at each of the two stations, as Y and Z, and having, by the screws, adjusted the telescope as before, let *t v* be the horizontal line at Y, and *w x* that at Z; then, the heights Z *v* and Y *x* being obtained by means of the staff set up successively at each opposite station, it may be easily proved that half the difference between them will be equal to the height of the ground at one point, as Y, above that at the other. This is however strictly correct only when the staves at Y and Z are considered as parallel to one another; but the error arising from their being in the direction of the earth's radii is quite insensible in any of the ordinary operations of this nature.

In using either of these methods, therefore, no correction on account of the earth's curvature is necessary; but when, from any circumstances, the spirit-level cannot be placed nearly midway between every two stations, and particularly when it can be placed only at one station, as Y, the difference between the height Z *v* of the visual ray at one station, and Y *t*, the height of the instrument at the other, will not, on account of the earth's curvature, be the correct relative heights of the ground at the two stations. For, let Y *z* be an arc of the earth's surface, supposed to be spherical; let also Y *t*, Z *v*, be in the direction of its radii, and let Y *y* be a tangent to the curve at Y: then *t v* being parallel to Y *y*, the difference between Z *v* and Y *t*, or *v y* (which may be considered as equal to Y *t*), will be Z *y*, the apparent height of Y above Z; whereas the true height should be Z *z*. Now, from the known magnitude of the earth, the distance *y z*, between the tangent Y *y* and the arc, can easily be computed when Y *z* or Y Z is of any given length. If this length is equal to 100 yards, we shall have $yz = 0{\cdot}02$ inches. Consequently, in a series of operations, carried on in the manner above described, with station lines not exceeding 100 yards in length, the error in the relative heights at the end of one mile would be little more than one-third of an inch.

On ascending or descending a steep hill, no other method can be adopted than that of placing the instrument at one extremity of the station-line and the staff at the other; but as these lines are then necessarily very short, the deviation above mentioned need not be regarded.

In the determination, on uneven ground, of the length of a base-line for the trigonometrical survey of a country, the relative heights of the ground, as at A, B, C, &c., when found as above, serve for the reduction of the measured hypothenusal lines A B, B C, &c., to the corresponding horizontal lines *m n*, *p q*, &c.; these being comparatively short, are then considered as circular arcs, and each is separately reduced to an arc of the earth's surface at the level of the neighbouring seas by subtracting from it the term $A\frac{h}{r}$, which is found from the proportion between the arcs and radii in the similar sectors. Here A is the horizontal line or arc, as, *m n*; *r* is the radius of the earth's curvature at the level of the sea, and *h* is the height of the ground at A, B, &c., above that level.

The profile of the ground is usually expressed on paper, in portions of any convenient length, for the purpose of enabling the engineer to determine the depths of his excavations, or the heights of the masses of earth to be raised, when it is proposed to execute a canal or road. A right line being drawn to represent one parallel to the horizon, and passing through the highest or the lowest point of the natural ground, the heights or depressions of the remarkable points, as A, B, &c., with respect to such line, are obtained by additions or subtractions from the numbers in the field-book, and are, by a proper scale, set out from that line on others drawn perpendicularly to it at intervals equal to the horizontal distances between the same points. The series of points thus obtained, being joined by hand or otherwise, give the figure of the required vertical section of the ground. In general, for the sake of distinctness, the scale by which the heights are set out is greater than that of the horizontal distances between the points.

When the difference of level only between two places is required, a rectilinear direction from one to the other is not necessarily that in which it is most convenient to perform the operation: a circuitous route is preferable when it presents fewer impediments from woods or marshes, or when the inequalities of the ground are of less magnitude.

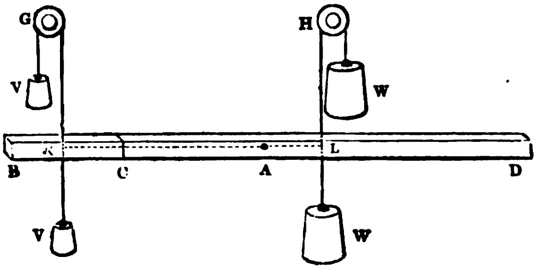
Among the operations of levelling, which, within a few years, have been performed on an extensive scale, may be mentioned the series of levels taken across the lands between the Black and the Caspian seas; and between the latter and the lake Aral, for the purpose of determining the relative heights of those waters: the series which, during the expedition of Colonel Chesney, were taken from Iskanderùn on the Mediterranean to Birehjik on the Euphrates; and near the Persian Gulf, between the latter river and the Tigris. To these may be added the extensive lines levelled in England and on the Continent for the several railways which have been executed or are in progress; and the important work executed under the auspices of the British Association, in order to determine the difference between the levels of the waters in the English and Bristol channels. The levels taken by Colonel Lloyd across the Isthmus of Darien, and those taken by the French engineers across the Isthmus of Suez, may also be referred to, although in both cases the results obtained have subsequently been called in question.

LEVER (*levare*, to lift up), the name of a common mechanical instrument, consisting of a simple bar of wood or metal, by fixing one point of which, called the *fulcrum*, a pressure at the end more distant from the fulcrum is made to counterbalance a larger pressure at the nearer end; or if both ends be equally distant from the fulcrum, equal pressures are made to balance each other. [BALANCE.]

The lever, considered as a machine, would require no further notice than a reference to the article POWER for the correction of a mistake incident to the conception of this and other machines. But as one of the fundamental principles of mechanics receives its most simple form in its application to the common lever, this instrument assumes a degree of theoretical importance which will justify some discussion of the subject: and the principle of the lever, which is often confounded with the lever itself, must be explained. Thus when it is said in popular writings on mechanics that all machines are reducible to the lever and the inclined plane (an assumption of a startling character if we consider, for instance, the works of a common watch) it is meant that every mode of communicating or relieving pressure is explicable upon the principle of one or other of those machines.

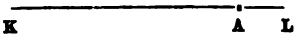
The first explanation of the lever was given by Archimedes, and that in so simple a manner, that while his method has always been the best for a popular view of the subject, it has never been surpassed, or even equalled, in rigor or purity, considered as a foundation for the science of STATICS.

It assumes two principles; firstly, that when a system is in equilibrium, the state of rest will not be disturbed if additional pressures, such as compensate each other, and would by themselves produce no motion, be introduced or removed; secondly, that when a weight is made to rest by being attached to an immoveable point (say it is suspended by a string) the point or pivot of suspension undergoes a pressure equal to the weight of the system, whatever may be the form of that system, or the disposition of its parts. Every science must be founded upon some axiomatic assumption; and perhaps there is none which is better entitled to preference than the fact that a given weight, say a pound, suspended by a string, exerts the same pressure on the string whatever its shape may be; namely, a pressure equal to the weight of the body. This being premised, a cylindrical or prismatic bar of uniform material will necessarily rest if a pivot be passed through its middle section at A: since there is no reason why it should preponderate on either side. Divide the bar into two parts, B C and C D, of which K and L are the middle points. At K and L suspend weights equal to the weights of B C and C D; but at the same time apply counterpoises of equal weight acting over fixed pulleys G and H: so that the new forces being such that each pair would be in equilibrium, they would not affect the equilibrium already established by means of the equality of the parts of the bar on each side of A. Now, equilibrium existing, we are at liberty to remove any forces which equilibrate each other, such as are the upper V and the weight of B C; such also as are the upper W and the weight of C D. For B C, if detached, would exert on the string which goes over the pulley G a pressure neither more nor less than its own weight (which is V); and C D, if detached from the pivot and from B C, would exert on the string of the pulley H a pressure equal to its own weight, or to W. But when these pairs are removed, there remain only the lower weights V and W; the substance and rigidity of the lever being retained to connect them, though its weight is removed or counterpoised. And K L, being the sum of the halves of the parts, is equal to half of the whole length, or to B A: take away the common part A K, and there remains B K, equal to A L, or K C equal to A L; also A K is equal to C L. Also V is to W in the proportion of B C to C D, or of K C to C L, or of A L to A K; that is, the weights V and W balance each other when they are inversely as their distances from the fulcrum A.



It only remains to show that no other weight except V, proportioned to W as above, will counterbalance W. If possible, let another weight V′, produce this effect when applied at K; and upwards, by means of the pulleys H and G, apply pressures equal to W and V′, the old weights V and W remaining as before. Then there are two systems which being separately in equilibrium are so when existing in connection. But the under and upper W balance each other; remove them, and there remain two unequal pressures, V and V′, which acting in opposite directions at the same point K, balance each other: a manifest absurdity. Consequently, no other weight except V can balance W when placed at K.

The most simple way in which the preceding result can be stated is as follows: when V placed at K balances W placed at L, about the pivot A, the number of *pounds* in V multiplied by the number of *feet* in KA gives the same product as the number of pounds in W multiplied by the number of feet in AL; (any other units of weight and length will do equally well, if only the same be used in both). The product of a pressure and the perpendicular let fall upon its direction from a fixed pivot or fulcrum is sometimes called the moment, sometimes the leverage, of the weight.



As the pressure on the pivot A is the sum of the weights V and W, if the lever were suspended at A, by a string passing over a pulley, a counterpoise might be applied in the shape of a weight equal to the sum of the weights V and W. But when a system is at rest, the equilibrium is not disturbed by making any point an immoveable pivot, and taking away any weight which may be there, leaving its place to be supplied by the re-action of the pivot. If then we were to make K a pivot, weights equal to W and $V+W$, acting downwards and upwards at L and A, would counterbalance one another, and since $V \times KA = W \times LA$, add $W \times KA$ to both sides, and we have $(V+W)\,KA = W \times KL$.

In English treatises on mechanics, it is customary to call one of the pressures which balance on a lever, the *power*, and the other the *weight*. Levers are thus distinguished as of the first, second, or third kind, according as the fulcrum, the weight, or the power, is in the middle.

LEVITICUS, is the third book of the Pentateuch, and is so called from Λευιτικον, the title given to the book in the Septuagint translation. In Hebrew it is denominated וַיִּקְרָא, *va yekra*, "and he is called," its first word. Both titles indicate the contents, as the book treats principally of the rites, ceremonies, sacrifices, and services, of the Hebrew religion, of which the charge was committed specially to the descendants of Aaron, who, as well as the other Levites, whose duties are more particularly detailed in the book of Numbers, were of the tribe of Levi.

That the book was written by Moses is proved, not only by the Jewish traditions, but by the intrinsic evidence afforded by passages in the book itself, and by others in the Old and New Testaments, in which he is mentioned as the inspired author. In Matthew viii. 4, Jesus himself appeals to the law that "Moses commanded." Some of the German Rationalistic writers have unsuccessfully attempted to prove that the laws originated long after the time of Moses; a conclusion manifestly incorrect, as they have a special relation to the Exodic period, having constant reference to life in a camp, and that camp under the command of Moses.

Leviticus contains little historical information: the deaths of Nadab and Abihu being the only event, besides the consecration of Aaron and his sons to the offices of the priesthood; and the time occupied is by some confined to the eight days employed in this ceremony, while others extend it to a month, and fix the month as the first of the second year after the departure from Egypt. As there are no chronological data given in the book the fact cannot be certainly fixed. The book is closely connected with that of Exodus, which concludes with a description of the sanctuary and the external holiness, while this commences by describing the worship itself. It further developes the legislation as propounded from Sinai, the beginnings of which are given in Exodus; exhibits the historical progress of that legislation; and contains the chief laws relating to the offerings, the feasts, the priests, and the definition of clean and unclean articles of food, not exactly in a systematic form, but in a certain order arising from the nature of the subject, of which the plan may be easily seen.

The book has doubtless also a prophetical character. The sacrifices and oblations which were to procure forgiveness of sins, have reference to the atonement to be made by Christ; as is shown by the whole Epistle to the Hebrews. "The whole service" [of the priests], says Bishop Marsh, "like the veil of Moses, concealed a spiritual radiance under an outward covering; and the internal import bearing a precise and indisputable reference to future circumstances and events, is stamped with the indelible proof of Divine contrivance."

Leviticus is almost uniformly treated of by writers and commentators in connection with the other books of the Pentateuch; but Jahn's *Einleitung*; Hengstenberg's *Authentie des Pentateuches*; Havernick's *Handbuch der Historisch-Kritischen Einleitung in das Alten Testament*, 1839; Knobel's *Handbuch zum Alten Testament*, vol. xii., *die Bucher Exodus und Leviticus*, 1858; Glaire's *Introduction historique et critique aux Livres de l'Ancien et du Nouveau Testament*, 1839, and Horne's *Introduction*, may be usefully consulted.

LEX. [LAW.]

LEX MERCATORIA, or LAW-MERCHANT, in a general sense, denotes that body of the usages and customs of merchants which has been adopted into the laws of most countries, and particularly of maritime states, for the protection and encouragement of trade. In this view it has been often termed a branch of the Law of Nations. In this general sense the law-merchant is at the present day extremely uncertain and indefinite, as different countries have adopted different portions of it, and the mercantile usages and customs common to all are few in number. Some centuries ago, however, when the transactions of commerce were less complicated, and the rules by which they were governed were consequently simple, the provisions of the Lex Mercatoria appear to have been better understood and ascertained. Thus we find the law-merchant frequently referred to in general terms by our earlier English statutes and charters as a well-known system, and distinguished from the ordinary law; as, for instance, in the stat. 27 Edw. III., 1353, it is declared "that all merchants coming to the Staple shall be ordered according to the law-merchant, and not according to the common law of the land;" and the Charta Mercatoria, 31 Edw. I., 1303, directs the king's bailiffs, ministers, &c., "to do speedy justice to merchants *secundum legem Mercatoriam*."

Lord Coke mentions the law-merchant as one of the great divisions of which the law of England is composed ('Co. Litt.' 11, b.), and the custom of merchants is said to be part of the law of England of which the courts are to take judicial notice. (Vanheath *v.* Turner, Winch's 'Reports,' p. 24.) This, however, must be understood to apply only to general customs, as the rule does not comprehend particular or local usages which do not form part of any general system. The generality of the expression has caused much misunderstanding, and merchants in this country have been often led to conceive from it, that when practices or rules of trade have become established amongst them so as to amount to "customs" in the common meaning of the term, they form part of the law of the land. This misconception has frequently led to improper verdicts of juries in mercantile trials. It is quite clear, however, that the Lex Mercatoria, when used with reference to English law, like the Lex et Consuetudo Parliamenti, merely describes a general head or division of the system. What customs or rules are comprehended under that division must always be matter of law for the consideration of the judges; and it is said by Chief Justice Hobart (in Vanheath *v.* Turner), that if they doubt about it, they may "send for the merchants to know their custom, as they may send for the civilians to know their law." In modern times the courts would inform themselves by directing an issue; and indeed it is chiefly in trying disputed questions before a jury that evidence of mercantile customs is given. As to what is understood by the law-merchant in England, and whence it is derived, see the Introduction to Smith's 'Mercantile Laws.'

LEXICON. [DICTIONARY.]

LEYDEN JAR. [ELECTRICITY, COMMON.]

LIBATION, an essential part of sacrifice among the Greeks and Romans. It consisted in the offering up of any liquid to the gods, usually of wine, water, or milk. Libations were also made at funerals, and on various occasions of public and private life when an appeal was made to the gods—as at solemn prayers, before drinking at meals or festivals, &c. (Pitisci 'Lexicon Antiq. Roman.,' tom. ii., pp. 74, 75; Gyrald., 'Syntag. Deorum,' l. xvii.)

LIBAVIUS FUMING LIQUORS. [TIN, *Bichloride of*.]

LIBEL is a malicious defamation, expressed either in writing, or by signs, pictures, &c., tending either to blacken the memory of one who is dead, or the reputation of one who is alive, and thereby exposing him to public hatred, contempt, or ridicule. (Hawk. 'P. C.')

This species of defamation is termed *written scandal*, and from the considerations that the offence is committed upon greater deliberation than the mere utterance of words, which are frequently employed hastily and without thought, and that the effect of a writing continues longer and is propagated farther and wider than verbal defamation, it is generally treated as a more serious mode of defamation than slander. [DEFAMATION; SLANDER.]

Whatever written words tend to render a man ridiculous or to lower him in the estimation of the world, amount to a libel; although the very same expressions, if spoken, would not have been slander or defamation in the legal sense of those words. [SLANDER.] To complete the offence, publication is necessary, that is, the communication of the libel to some person. The mere writing of defamatory matter without publication is not an offence punishable by law; but if a libel in a man's handwriting is found, the proof is thrown upon him to show that he did not also publish it.

There are two modes in which libellers may be punished, by indictment and by action.

The former mode is for the public offence, for every libel has a tendency to a breach of the peace by provoking the person libelled; the latter, by civil action on the case, to recover damages by the party for the injury caused to him by the libel.

On the criminal prosecution it is, at common law, wholly immaterial whether the libel be true or false, inasmuch as it equally tends to a breach of the peace, and the provocation, not the falsehood, is the thing to be punished; and therefore the defendant on an indictment for publishing a libel was not allowed to allege the truth of it by way of justification. But in a civil action the libel must appear to be false as well as scandalous, for the defendant may justify the truth of the facts, and show that the plaintiff has received no injury at all.

But although the truth of a libel is no justification in a criminal prosecution, except when pleaded under the recent statute, 6 & 7 Vict. c. 90, hereafter mentioned, yet it is so far considered an extenuation of the offence, that the Court of Queen's Bench will not grant a criminal information unless the prosecutor by affidavit distinctly and clearly denies the truth of the matters imputed to him, except in those cases where the prosecutor resides abroad, or where the imputations are so general and indefinite that they cannot be expressly contradicted, or where the libel is a charge against the prosecutor for language held by him in parliament. And it has been said that a grand jury should be governed by the like rule in finding an indictment for the offence.

A fair report of judicial proceedings does not amount to a libel, but a publication of ex-parte proceedings before a magistrate may be punished as such.

A petition, containing scandalous matter, presented to parliament or to a committee of either house, and legal proceedings of any kind, however scandalous the words used may be, do not amount to a libel. But if the petition were delivered to any one not being a member of parliament, or the legal proceedings were commenced in a court not having jurisdiction of the cause, they would not be privileged. Confidential communication reasonably called for by the occasion, as charges made by a master in giving the character of his servant to a party inquiring after it, or a warning by a person to another with whom he is connected in business as to the credit or character of a third party about to deal with him, are considered as privileged communications, and are not deemed to be libels unless malice be proved, or the circumstances be such that malice may be inferred by the jury.

After some controversy, it was settled that the jury, in a criminal prosecution for libel, must find not only the fact of publishing, but whether the matter in question be a libel or not (32 Geo. III., c. 60); but in a civil action the question whether the publication is or is not a libel is decided by the judge or court.

The punishment in a criminal prosecution may be fine and imprisonment; and upon a second conviction for publishing a blasphemous and seditious libel, the court may sentence the offender to banishment for any term it may think fit. (1 Geo. IV. c. 8.)

The law of libel had been frequently complained of, and with some appearance of reason, particularly that part of it which prevented the defendant from giving evidence of the truth of the libel in justification when subjected to a criminal prosecution. Almost the only reason, if reason it can be called, alleged in favour of the old law, the one already alluded to, that the libel, whether true or false, equally tends to a breach of the peace; or, as it has been somewhat whimsically said, the being true makes the libel more likely to produce a breach of the peace. Lord Mansfield, indeed, from the bench has said, "the greater the truth, the greater the libel." After much discussion had taken place upon this subject, the statute 6 & 7 Vict., c. 96, was passed, which enables the defendant, in pleading to an indictment for a libel, to allege the truth of the matters charged, and that it was for the public benefit that they should be published. The truth of the libel may then be inquired into at the trial, but does not amount to a defence unless the publication was for the public benefit. If, after such a plea, the defendant is convicted, the court may, in pronouncing sentence, consider whether the guilt of the defendant is aggravated or mitigated by the plea.

By the same statute, a defendant is now enabled in an action for slander, or for libel (giving notice in writing to the plaintiff at the time of pleading, of his intention), to give in evidence, in mitigation of damages, that he made or offered an apology before action, or as soon afterwards as he had an opportunity, in case the action was commenced before. And in an action for a libel in a newspaper, or other periodical publication, the defendant may plead that it was inserted without malice, and without negligence, and that before action, or at the earliest opportunity afterwards, he inserted a full apology for it; or if the newspaper, &c., be ordinarily published at intervals exceeding one week, had offered to publish the apology in any newspaper, &c., to be selected by the plaintiff. Upon pleading such a plea, the defendant may pay into court a sum of money by way of amends for the injury sustained by the publication of the libel. (8 & 9 Vict. c. 75.)

The printer of a libel is liable to prosecution as well as the writer, and so is the person who sells it, even though ignorant of its contents.

By the 6 & 7 Wm. IV., c. 76, s. 19, a bill of discovery may be supported against the editor of a newspaper or other person concerned in the publication or interested in the property thereof, to compel a disclosure of the name of the author of the libel, or of the name of any person connected with the publication against whom the party libelled may think proper to bring an action.

(Bl. *Com.;* Starkie and Holt, *On Libel;* Selw., *N. P.;* Bac. *Abr.*, tit. 'Libel.')

LIBEL, in Ecclesiastical Law. [Ecclesiastical Courts.]

LIBER REGIS, another term for the 'Valor Ecclesiasticus' of Henry VIII. By 23 Henry VIII., the payment of annates, with all sums paid for palls, bulls, and the like, at the consecration of every new prelate, was restrained. This was followed by 26 Henry VIII., for the payment not only of "first-fruits of all dignities, benefices, and promotions spiritual," but also of an "annual pension of the tenth part of all the possessions of the Church, spiritual and temporal, to the king and his heirs," as supreme heads of the Church of England. The 'Valor Ecclesiasticus' is the return which the commissioners under this Act made into the exchequer. This record, in full, except certain portions which have been lost, was published by the commissioners upon the records of the realm, in 6 vols. fol., 1810-1834. An abridgment of it is preserved in the Office of First-Fruits, entitled 'Liber Valorum,' and was the foundation of the Liber Regis, vel Thesaurus Rerum Ecclesiasticarum,' by John Bacon, Esq., receiver of the first-fruits, with an appendix, &c., 4to, Lond., 1786. This latter work also contains an account of such benefices as have been since discharged from any payment to the above revenues, on account of the smallness of their income. See further, on Queen Anne's Bounty, in article Benefice.

LIBERTI'NUS. In the Roman polity persons were divided, with respect to status or condition, into freemen (liberi) or slaves (servi). Freemen were again divided into persons who were born in a state of freedom (ingenui), and persons who had been manumitted (libertini). ('Gaius' i., 10, &c.; and compare Horace, 'Serm.,' i. 6, v. 6, 21.) A manumitted slave was called "libertus," that is, "liberatus," "freed," with reference to the act of manumission, and to his master, who, by manumitting him, became his patron (patronus): he was called "libertinus" with reference to the class, to which, by the act of manumission, he belonged. It is sometimes said in modern works that the "libertinus" was the son of the "libertus;" and such, according to Suetonius, was the meaning of the term "libertinus" in the time of the censor Appius Claudius, and for some time after ('Claud.,' c. 24); but the term "libertinus" in aftertimes was used in the way here stated.

A manumitted slave might either become a full Roman citizen or a Latinus [Latinum Jus], or he might obtain no higher privileges than belonged to the class called Dediticii. The grounds and conditions of this triple distinction are fully explained by 'Gaius' (i., 12, &c.) The three modes of manumission, by any one of which the freedman might obtain the rights of a Roman citizen, were the "vindicta," "census," and "testamentum." The practice of manumitting slaves having become very common, and being productive of great inconvenience, various provisions in restriction of the power were imposed by the Lex Aelia Sentia, passed in the time of Augustus. By this law, if a person manumitted a slave for the purpose of defrauding his creditors, or for the purpose of detracting from the rights of his patron, the manumission was void. By the Lex Furia (Fufia) Caninia, also passed in the time of Augustus, before the Lex Aelia Sentia, a man could only manumit by his testament a certain proportion of his slaves. This enactment was repealed by Justinian's Legislation.

Though the sons of "libertini" were ingenui, it appears from numerous passages of the Roman writers that they were not unfrequently exposed to the taunts and sneers of those who could boast a pure descent from free-born ancestors. Horace says of himself, "Quem rodunt omnes libertino patre natum." ('Serm.,' i. 6, 46.)

It appears from the definition of Gentilis, as given or sanctioned by the Pontifex Scævola (Cic., 'Topic.,' 6), that a "libertinus" could have no Gens; but the doctrine of the Gentilitas (gentilicium jus), which was once of great importance as to the succession to the property of an intestate, had fallen into desuetude in the time of Gaius (iii., 17). Two inscriptions (Nos. 3024, 3029) in Orelli, probably of a late date, commemorate the fact of a freedman marrying his former mistress (patrona).

The relation between a freedman and his patronus is more properly discussed under the head of Patronus.

LIBERTUS. [Libertinus.]

LIBERTY. This word is the Latin *libertas*. The corresponding Teutonic word is *freiheit*, or, as it appears in English, *freedom*.

Liberty and freedom are familiar words with indefinite meanings. "Liber," the adjective which corresponds to the noun "libertas," is properly opposed to "servus," or slave; and libertas is the status of a freemen, as opposed to servitus, or the status of a slave. This division of freemen (liberi) and slaves (servi) was the fundamental division of persons in the Roman law (Gaius, i. 9). This word liberty, then, in its origin, indicates merely the personal status of a man as contrasted with the condition of servitude. In Greek the like opposition is expressed by two other words (*δεσπότης, δοῦλος*). But the word libertas had also a political meaning among the Romans. When the Romans had ejected their last king, they considered that they had obtained their liberty. (Livy, ii. 1.) The political meaning of libertas (liberty) was derived from the contrast of liberty and servitude in the person of individuals; and if the mass of a nation were subjected to the arbitrary rule of one man, that was considered a kind of servitude, and the deliverance from it was called libertas, a term which in this sense is clearly derived from the notion of liberty as obtained by him who was once a slave.

In the Greek writers the words (*δεσπότης* and *δοῦλος*), which respectively signify master and slave, were also applied in a political sense to signify monarch and subject. The Persian king was master (*δεσπότης*) and his subjects were slaves (*δοῦλοι*).

The political sense then of liberty and freedom, if traced to its source, is founded on the notions of personal liberty as contrasted with personal servitude. He who became free from being a slave in a republic became a member of the state, in which he formerly had no political existence. It is implied by the circumstance of his becoming free that he became a citizen, though positive law, as among the Romans, might limit the degree in which he thereby obtained citizenship. [CITIZEN.] Slavery may and did exist in many states of antiquity which were under monarchical or tyrannical rule; but he who was the slave of an individual in any such state, and obtained his freedom, did not thereby become a citizen, but was merely released from the duty that he owed to his master: he still owed together with others the duty of perfect obedience to an individual monarch or tyrant.

The words liberty and freedom, as political terms, have always been used to express a condition of a people in which they are to some degree at least secured against the arbitrary rule of an individual or of a small number of persons; and the word slavery, in its political sense, is applied to nations in which the mass of the people have not reasonable security for their lives and property against the capricious rule of one man or of a number of persons who form a small minority of the whole.

That which is really meant by political freedom and liberty is nothing more than a form of government which shall in some degree at least secure to the people the enjoyment of life and of their property against the tyranny of one man or of a few. Freedom and liberty then are terms which can only be applied to constitutional governments [CONSTITUTION], and to republics, in the proper sense of that term. There is no political liberty or freedom under any other form of government, though under a monarchy, when the administration is good, there may be in many respects more personal freedom than there is in a pure democracy. But the essential quality by which political liberty or freedom is distinguished is simply this: the sovereign power is not in the hands of one or of a small minority, but it is either distributed among the whole community or a considerable part of it.

Political liberty does not exist in some civilised nations in Europe: in France, for instance. Political liberty does not exist in Russia. In some countries where it does not exist, it is the general opinion that its existence would be a benefit to the whole nation. In other countries the mass of the people are still in such a condition that political liberty could not exist, for political liberty, as already stated, means that the sovereign power must be in the hands of a large number, and they must possess intelligence enough to enable them to exercise and keep the power; but there are nations where the mass of the people are too ignorant to exercise or keep any political power.

A nation which strives for its liberty strives for a popular form of government, whether it be a constitutional kingly form or a democracy. But liberty is a specious word, often ill understood; and many who have cried out for liberty have either not considered exactly what it is they want, or they have supposed that liberty would free them from many evils which they consider to be peculiar to a state of political slavery. It is now generally admitted, that in those states where a large part of the population have equal political knowledge with the few who direct administration, the general interests are best served by this large number participating in the government. Political liberty, then, to some extent or degree, is, in many countries, necessary for securing the advantages of good administration. But there are many evils incident to states, which are not due to the want of political liberty; and it is therefore a matter of importance for those who would make changes in government to consider whether the evils of which they complain are owing to a want of political liberty or to other causes.

The notion of political liberty has been based upon the analogy already pointed out between Political Liberty and Personal Liberty; which is a false analogy, though an historical one. Man, it has been assumed, is naturally free. No man is naturally or by nature another man's slave. As no man, it is said, is naturally a slave, so all mankind have naturally a right to political liberty, and just government, it is said, arises from the consent of the governed.

On these assumptions rests the American Declaration of Independence: "We hold these truths to be self-evident: that all men are created equal; that they are endowed by their Creator with certain inalienable rights; that among these are life, liberty, and the pursuit of happiness; that to secure these rights governments are instituted among men, deriving their joint powers from the consent of the governed," &c.

In this passage Liberty seems to mean the personal status, which is opposed to slavery; and it is on the assumption of the equality by birth and the endowment of all men with certain inalienable rights, that this instrument would found the American title to Political Liberty. It involves the doctrine of the social contract, and assumes, as an historical fact, an origin of governments by consent of the governed. It was also promulgated in a country in which a very large number of persons were then slaves, and in which a large number still are slaves.

If theories of government are to be tested by historical facts, it would be consistent with such facts to say, that men are not created equal; that they have not been endowed with liberty, for a large part of them have always been slaves; and that governments have been constituted without the consent of the governed. These are real facts: those assumptions are untruths.

Political liberty rests on no such sorry basis as the Declaration of Independence places it on. That nation which can obtain it and maintain it is in a better condition than if it were politically a slave even to the wisest of masters; and when it is able to obtain and maintain that liberty, it is right, or in other words it is for the general interest, that a nation should, by force if necessary, alter that form of government which is political slavery.

That liberty promises to be most stable which is the growth of long time and the result of a perpetual struggle between a master and his slaves, in which the master has not ceased to be master all at once, but has always lost something in the contest.

That which is of sudden growth or is the offspring of Revolution, is often premature, and always insecure; for liberty so acquired may only be a step from a state of political slavery to a more wretched state; it may be a step from a state of slavery, mild and tolerable, to an anarchy, which of all things is most intolerable.

The words Liberty and Equality often go together, and each of them in so doubtful a sense that one hardly knows what to make of them. Liberty is often used, apparently without people considering what they really mean, in the sense of freedom from restraint. But this kind of Liberty is inconsistent with Political Liberty properly understood; and all men's liberty of action is and must be restrained by positive laws in every well-ordered community. Every law that forbids any act directly or by implication abridges Liberty, and such abridgement is always a universal benefit when the law which so abridges liberty only abridges it in cases where it is useful to all that it should be abridged, and where the law is so framed as to accomplish that object. Equality, in its unlimited sense, can no more exist in any state than perfect individual liberty; for if each man is left to exercise his industry in the best way that he can, without interfering directly with the industry of others, some will be richer, and happier, and wiser than others. The only Equality that can be approached to in a well-ordered state is that Equality which is the result of a good polity, which polity, so far as it is consistent with the universal good, secures alike to every individual in the State the free enjoyment of his industry, wealth, and talents, imposes restraint on all alike, and makes all alike bear the burden of taxation and of the services due to the State. Further, it gives to as large a number as it can, consistently with the universal interest, an equal share in the sovereign power; but no polity that has ever yet been framed has ever given an equal share in the sovereign power to all the members of a community: such an Equality is impossible.

The Declaration of Rights published by the French National Assembly in 1791 contains the words "free," "equal," "rights," "liberty," and many others, all used in a manner as remote from precision as the most confused understanding could suggest. This strange sample of nonsense has been examined and dissected by Bentham in his 'Anarchical Fallacies.'

The word Liberties is often used to express those particular constitutional principles or fundamental laws by which the political liberty of a nation is secured. If the British parliament should attempt to abolish the Trial by Jury in all cases, or the Habeas Corpus, such an attempt would be called an attack on the liberties of Englishmen.

Liberty is also used in reference to the religious institutions of a state. Liberty of conscience properly implies that neither is coercion exercised upon, nor inducements offered to, nor disabilities imposed upon, the form of faith of any of the members of the state; but generally in effect it is much more restricted, and the unimpeded exercise of the peculiar form of worship is all that is understood.

LIBERTY. The general nature of a liberty, as a portion of the royal prerogative in the hands of a subject, has been already described. [FRANCHISE.] Liberties were at first chiefly granted to monastic and other religious establishments, in ease of the consciences of the royal grantors, or in testimony of their devotion to the Church; and most of those now in existence are derived from an ecclesiastical source. They were afterwards granted as means of strengthening municipal corporations.

Though all liberties emanate from the prerogative, a distinction is usually made between such liberties as have been actually exercised by the crown before the grant to the subject, and such as (being merely latent in the crown) are said to be created *de novo* upon their being granted. The former, when by escheat, forfeiture, or otherwise, they come again to the crown, are extinguished by merging in the general prerogative, and cannot afterwards be regranted as existing franchises: the latter still have continuance for the benefit of the crown or of any subsequent grantee. To the former class belong such privileges as the right to have the goods of felons, &c., waifs, estrays, and wreck, arising within the lands of the grantee; to the latter, the return of writs, the right of holding fairs and markets and taking the tolls, the right of holding a hundred-court or a court-leet, the privileges of having a free-warren [WARREN; PARK], and the like; and in such cases the franchises, even whilst in the king's hands, are exempt from the jurisdiction of the ordinary officers of the crown, and are administered by bailiffs or other special officers, as when in the hands of a subject.

The fines paid to the crown for grants or confirmations of liberties are shown by Madox to have formed no inconsiderable part of the royal revenue. In his 'History of the Exchequer,' he quotes the particulars of about 200 liberties, granted principally by King John. The following may serve as a specimen of the terms upon which the parties fined or made agreement with the crown. The men of Cornwall fine in 2000 marks and 200 marks for 20 palfreys estimated at 10 marks each, for a charter for disafforesting the county and choosing their own sheriffs. The men of Brough fine in 20 marks and 5 marks for a palfrey, for a market on Sunday, and a fair for two days. The men of Launceston fine in 5 marks for changing their market from Sunday to Thursday. Henry de la Pommeraie fines in 5 marks "that the men of Lidford may not have a better liberty than the men of Exeter." Alanus de Munbi fines in 100 marks and 3 good palfreys for a charter of exemption from suit at county courts and hundred-courts for his life. Thomas of York, son of Olivet, fines in one huntsman (*unum fugatorem*) that he may be alderman in the merchant's guild at York. Agnes, the widow of Walter Clifford, fines in one good palfrey to have her manor of Witham in Kent, and that the men of the said manor, being her men, be acquitted of shires, and hundreds, and suits to the county courts and aids of sheriffs and bailiffs, and for the king's letters-patent thereof. The burgesses of Shrewsbury fine in 20 marks and one palfrey that no one shall buy within the borough new skins or undressed cloth, unless he be *in lot* (in *lotto*), and assessed and taxed with the burgesses. [SCOT AND LOT.]

Many of these franchises having been found to interfere with the regular and speedy administration of justice, the extension of them by fresh grants was frequently the subject of very loud complaints on the part of the Commons in parliament, who represented them as prejudicial to the crown, an impediment to justice, and a damage to the people. It appears by the Parliament Roll, that Edward I., towards the close of his reign (in 1306), declared that after the grant which he had made to the Earl of Lincoln for his life, of the return of writs within two hundreds, he would not grant a similar franchise *as long as he lived* to any except his own children, and directed that the declaration should be written in the Chancery, the Gardrobe, and the Exchequer. And in 1347, Edward III., in answer to a strong remonstrance, promised that such grants should not in future be made without good advice.

The form in which the crown granted views of frank-pledge [LEET] and other franchises may be seen in the charters granted by King Henry VI. to Eton College, and King's College, Cambridge. (5 'Rot. Parl.,' 51, 97.)

A person exercising a franchise to which he has not a legal title may be called upon to show cause by what authority he does so, by a writ of *quo-warranto*, or an information in the nature of a *quo-warranto*. [INFORMATION; QUO-WARRANTO.] And parties disturbed in the lawful exercise of a francise may recover damages against the disturber in an action.

LIBRA (the Balance). In the older Greek writers the Scorpion occupies two constellations of the ZODIAC, or rather the body of the animal occupies one, and the claws, *chelæ* (χηλαί), another. We say this, because though the chelæ were certainly a part of the Scorpion, yet they are often mentioned (as by Aratus, for instance) by themselves, as if they formed a distinct constellation. The word *chela* had several significations; so that it may have been by simple mistranslation that the Romans (according to Hyginus, Virgil, &c.) gave the name of Libra to the part of the heavens in question, and drew back the claws of the Scorpion to make room for the scales.

Libra is surrounded by Scorpius, Ophiuchus, Virgo, Centaurus, and Lupus. Its star β is the vertex of an isosceles triangle, of which Arcturus and Spica (α Virginis) are at the extremities of the base. Its principal stars are as follows:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
α	9	4895	2
δ	19	4939	4
γ	20	4950	3
β	27	5034	2
ζ	32	5089	4
	39	5138	4
κ	43	5176	4
η	44	5190	4
χ	45	5251	4
θ	46	5257	4
ψ	48	5290	4

LIBRARIES. The word library is used to denote a collection of books, whether large or small, and also the repository in which that collection is placed, whether a few shelves or a room, a house or a palace. The English term is derived from the Latin language, but in Latin itself a library is usually expressed by the word "bibliotheca," taken from the Greek. The Greek phrase thus adopted by the Romans has passed from them not only into every language of the Romanic family, but into almost every other cultivated language but our own, for strangely enough, though repeated attempts have been made to naturalise it, it has never taken root in the English vocabulary, which is not usually so fastidious.

Of late years the study of libraries—their formation, arrangement, management, and history—has been raised to the dignity of a science. Schrettinger in German, Molbech in Danish, Constantin Hesse in French, have written respectively on "Bibliothekwissenschaft," "Bibliothekvidenskab," and "Bibliothéconomie," a branch of knowledge for which no English term has yet been invented. In spite of the proscription of "bibliotheque," some phrase like "bibliothecology" will probably ere long find its way into our dictionaries, to keep company with "ecclesiology," and other modern innovations. A mode of representing the German phrase in English is likely to be required, as the science itself has found so much favour in German eyes that a periodical was commenced in 1840, which still continues to be published expressly for the purpose of reviewing books that touch upon it. Dr. Petzholdt's 'Anzeiger für Literatur der Bibliothekwissenschaft.' In addition to the circumstances which have always operated to render great libraries objects of interest to enlightened men, the position of libraries in general has been remarkably altered in the course of the present century, and more especially in the course of the last forty years. The operation of the causes which produce these results is rapidly progressive, and the subject appears likely to increase in interest with every succeeding year.

The existence of a library of some kind must date back nearly as far as the existence of writing. The book which is emphatically called "the book"—the Bible—is itself a collection of books of different kinds: poetry, prophecy, and history of different ages, from the time of Moses to the time of Malachi. In Greek its name is not the 'Bible,' but the 'Bibles'; and in the middle ages it was often called 'the Library,' 'the Bibliotheca.' It probably constituted among the early Hebrews the whole library of the Synagogue. Its first translation, the Septuagint, was expressly written to enrich a larger library—the great collection of books which, founded by Greeks on the soil of Egypt, was destined to become the greatest and most famous collection of all antiquity. The book which was first introduced to the Alexandrian library of the successors of Alexander the Great, as an exotic curiosity, became in the course of centuries the book of the religion of Egypt—till, as we shall see, that noble library finally perished after its varied fortunes of nine hundred years, by command of the Mohammedan caliph, who condemned all books as useless or injurious but the Koran. That library must then have embraced thousands of volumes which were a comment on that early translation for which the world was indebted to its founders. At this moment the royal library of Stuttgard contains 8700 editions of the Bible, and that of the British and Foreign Bible Society in London, is almost entirely a collection, and a very imperfect one, of the translations and comments on that single volume.

As one book thus becomes connected with, and even essential to, the understanding of another, so whole libraries of books stand in the same relation. The library just mentioned, that of the British and Foreign Bible Society, contains, as we learn from Mr. George Bullen's valuable catalogue, translations of the Scriptures into upwards of 150 languages, many of them languages in which no other book exists. The library is thus of essential importance, not only to the biblical but to the philological student. At the same time the investigator into languages is unable to make full use of the treasures it contains unless he has also access to a large collection of grammars and dictionaries, a library of entirely a different description. It is evident that if a biblical and a philological library existed in different parts of the same city, unconnected with each other, a great service would be rendered to the frequenters of both by bringing them under the same roof, and rendering them accessible at the same times. The collections might remain precisely the same, the expenses of management might by the blending of the two into one be easily reduced, but the advantages would be great, and they would be mutual. The biblical student and the missionary might make use of the dictionaries to study the Hebrew and Arabic and Tahitian Bibles, the philological student might make use of the Bibles to study the Hebrew and Arabic and Tahitian languages.

The benefit to be drawn from the amalgamation of libraries, so far from decreasing, seems to increase, the farther that amalgamation is carried. It is both theoretically and practically impossible to draw any strict limitation to the bounds of any extensive study. To pursue the instance of the Biblical student, how many sciences fall within his range. The ecclesiastical law is founded on the Scriptures, and in every church and country there are different forms of ecclesiastical law. The history of the Church is inextricably connected with the history of every Christian state. The geography of the Holy Land has been for ages a theme of research, and the natural history of the Scriptures another. Church architecture is one of the most prominent forms of the art, painting has had its highest triumphs in scriptural subjects. On all these sciences, arts, and studies, whole libraries have been written, and there is hardly a book of those libraries which the student of any of those subjects may not have occasion to consult. If a missionary, the field of his inquiry becomes still more widely extended. A missionary to Mohammedan countries ought to be acquainted with the Koran, to India with the Vedas, to China with the books of the Buddhists and the works of Confucius and Laou-Tsze. The historian of Christian missions, the historian of religion in general, should have some knowledge of all the creeds of the heathen.

It would seem to follow from these considerations that the union of whole libraries is as essential for the purposes of study as the bringing together of single books, and that it should be an object with all who wish to cultivate the progress of knowledge, to favour the form[illegible]ting every public library of the largest possible extent, to contain [illegible]hat memo[illegible]s of value.

This view [illegible] supported by the authority of one who, when his passions were [illegible]concerned, was perhaps the most clear-sighted man of genius who ever dealt with practical subjects. In the report presented in 1860 to the Emperor of the French on the state of the imperial library at Paris, reference is made to the opinion expressed by his uncle, the first Napoleon, in a note dictated on the 10th of February, 1805—"many ancient and modern works are wanting in the great library," said Napoleon, "which are found in the other libraries of Paris, and of the departments. A list should be made of these books, and they should be taken from the minor establishments, to which should be given in exchange works which they do not possess of which the great library has duplicates. The result of this operation would be, that when a book was not found in the imperial library it would be known for certain that it did not exist in France."

The notion of a central and universal library of this kind has the advantage of being, not only philosophical, but popular. It has been a prevalent belief in several countries that this ideal library actually existed. The Vatican at Rome was long supposed to be such a collection, and to contain an enormous quantity of volumes. The Rev. Mr. Eustace, an English Catholic priest, who published a 'Classical Tour in Italy,' in 1813, said, in speaking of the printed books of the Vatican library, "Their number has never been accurately stated; some confine it to 200,000, others raise it to 400,000, and many swell it to a million—the mean is probably the most accurate." The most recent historian of the collection, Zanelli, in 1857, speaks of it as "holding the first place among the libraries of the world, both by its antiquity and the value and number of its volumes and manuscripts." At Oxford, in the early part of the present century, it was almost an article of faith with the under-graduates that the Bodleian library was only second to the Vatican, and further, that it contained every printed book. The number of volumes in it was usually stated to visitors at half a million: a German statistician, Schnabel, on the faith of the assertion in the 'Oxford Guide' of its near approach to the Vatican, raised the number in print to 700,000. The same notion of its containing every printed book was current in London at the same time respecting the British Museum. In all three cases the belief was a most egregious error.

Two German writers of reputation, Denis, in 1775, in his 'Introduction to Bibliography,' and Blume, in 1824, in his 'Iter Italicum' reduce the number of printed volumes in the Vatican to 30,000. Valery the Frenchman, in 1826, speaks of it as 80,000. The marquis Melchiori in his 'Guida Metodica,' printed at Rome in 1836, gives the number at 100,000; and as Zanelli twenty-one years after does not venture to correct him and gives no number at all, it may be assumed that Melchiori was near the mark. An official return of the Bodleian librarians to the House of Commons in 1849 stated the number of their volumes then, after all the increase of half a century, at 220,000 only; and the British Museum in 1820, contained less than 116,000, while though it has now in 1860, attained to more than five times that number, and more than doubles the Bodleian, it is still far indeed from a state of even tolerable completeness.

It is remarkable at how recent a date the period of really extensive libraries commenced. Adriano Balbi, the Italian statistician, who in his ingenious essay on the library of Vienna, published in 1835, furnished a large body of information on the subject critically sifted, gives an estimate of the number of books in several of the great libraries of Europe in 1789, at the commencement of the French Revolution. The Imperial Library at Vienna was then in his judgment the largest collection in Europe, and contained 196,000 volumes. Three other libraries in Germany stand nearest to it in his estimate. To the royal library at Dresden he assigns 190,000; to the royal library at Berlin 160,000; to the university library at Göttingen also 160,000 volumes. To the Zaluski library at Warsaw he gives 150,000; to the royal library at Paris 149,000, only. The only English library he mentions is the Bodleian, to which he assigns 135,000 volumes in 1789.

At the time to which Balbi refers,—the outbreak of the French Revolution,—the library of the king of France in Paris was currently believed by some to amount to three hundred thousand, by others to five hundred thousand volumes, and was considered by Frenchmen and competent judges the noblest collection in Europe. The authority on which Balbi assigns it so low a number as 149,000, is that of actual counting—the fatal test, the application of which has suddenly shrunk the dimensions of so many far-famed libraries. Van Praet the librarian, who himself accomplished the operation, tells us in the preface to his 'Catalogue des livres imprimés sur velin,' published in 1822, that "counted one by one in 1791, the number of volumes only amounted to 152,868; namely, 23,243 in folio, 41,373 in 4to., and 88,252 in 8vo. and of lesser sizes."

Guided by this positive information, Balbi is of course perfectly justified in giving the number he states. But he seems not to have been aware that the Zaluski library, which he only places immediately above it, was counted also, and with a result which is startling. Seised by the Russians in 1795 and transported to St. Petersburg, where it now forms the basis of the Imperial library, the volumes were counted on their arrival, and were officially stated to amount to the enormous number of 262,640. The enumeration which was supplied by the Russian government, and is given with various particulars in the Report of a Committee of the House of Commons on the Museum library in 1836, is not very clear in some respects, for in one portion of it, 43,000 pamphlets are inserted as so many volumes, and in another, 120,000 pamphlets which are mentioned are not added into the total sum. But estimating these 163,000 pamphlets as 16,300 volumes, of ten to a volume, according to a convenient rule adopted by Balbi, the number of volumes transported to St. Petersburg will be in round numbers upwards of 235,000. It should not be forgotten that there is undeniable evidence that the library had been seriously pillaged while still at Warsaw. If this number be correct, and it is as well vouched for as the census of most libraries, it will not only follow that the collection of books made in his lifetime by one Polish bishop with the assistance of another, was the largest collection ever made at private expense, but that it actually surpassed in numbers the magnificent library of the kings of France, and was at the head in that point of all the collections in Europe, some of which had been gathering together for centuries at the expense of nations.

In the wars which followed the French revolution, many a revolution took place in the affairs of libraries. The royal library of France was augmented enormously both in extent and value by the absorption of the libraries of the suppressed religious houses, and the contributions levied on conquered foreign states. The latter treasures were restored at the restoration of peace, but the French library remained in 1815 what it still continues, the largest and most celebrated library in Europe. Van Praet in 1822 spoke of it as having increased two-thirds from the time when he counted it in 1791, and as containing 450,000 volumes, not including as many pamphlets and pieces bound in volumes or kept in portfolios, and it was then augmenting at the rate of 7000 volumes a year, and 3000 fugitive pieces. In the year 1850 the number of volumes in the library, according to an official return procured by the British ambassador, was 750,000, of which 50,000 were volumes of tracts or pamphlets containing about ten tracts each, and therefore in all 500,000. In 1855, in the preface to the new classed catalogue now in course of publication, it was stated that the collection comprised 1,500,000 volumes and pamphlets, without drawing a distinction between the two.

If we adopt Van Praet's estimate of the number of volumes and tracts being equal, there will then be 735,000 volumes and 735,000 tracts; and counting the tracts according to Balbi's method at ten to a volume, the number of volumes in 1855 will be 808,500, to which if we add augmentations at the rate of 11,000 volumes a year, the total will in 1860 be 863,000.

The Zaluski library, removed to St. Petersburg, was for some time left there in a state of such neglect that, when again counted in 1803, it was found to have diminished by decay and theft to 238,633 volumes—a number still remarkably high. It was again injured by its sudden removal, on Napoleon's invasion of Russia, from St. Petersburg to a remote village, to keep it out of the way of the invaders, who, in this case, as there were Poles among them, would only have been recovering their own property. In 1833 and 1834 it was augmented, as we learn from the Official Guide to the library, by more than 125,000 volumes, procured by the Emperor Nicolas from the spoils of several Polish magnates and public institutions, in particular from those of Prince Czartoryski's country seat at Pulawy and the library of the society called the "Friends of Knowledge" (the Polish Royal Society) at Warsaw. Finally, the more ordinary and creditable mode of augmenting the library by purchases and donations came into operation; and in the Official Guide for 1850 we are told that the library then contained upwards of 600,000 volumes of printed books, together with collections of manuscripts, engravings, &c. In the annual report of the librarian for 1858, the last we have seen, the number of printed volumes, pamphlets, and pieces added in that year is given as 38,136; and in the same year the officials of the library issued a detailed comparison of its state in 1850 and 1858, from which the following items are taken.

	In 1850.	In 1858.
Of printed books, volumes . . .	640,000	802,717
Of manuscripts and collections of autographs, volumes	21,415	28,536
Of engravings, pieces	39,815	63,503

In the 'Guide to the Imperial Public Library of St. Petersburg,' published in 1860, the numbers given are 840,853 printed volumes, 29,045 manuscripts, and 66,162 engravings.

It would appear from these numbers that the library of St. Petersburg is now the second library of the world, and increasing with more rapidity than any other. This impression, however, must not be too hastily adopted. There is a collection now publishing by the English Patent Office, of all the descriptions of patents of inventions that have been enrolled there from the institution of patents in the time of James I. up to the present year. This voluminous and costly collection, which is printed at the expense of patentees, is presented by the Patent Office to a great number of foreign libraries, and among others to the imperial library at St. Petersburg. The number of patents for the year 1857 is no less than 3200, published in as many separate pamphlets, which are bound in the set at the British Museum in 96 thickish volumes. In counting the volumes at the

Museum they will be reckoned at 96, while we are told on good authority that at the library at St. Petersburg they are counted as 3200, making a difference in the returns of the same annual set of more than 3100, and in the returns for the whole collection of patents of more than 24,000 volumes.

Another great European library is frequently said to contain more than 800,000 volumes—the collection at Munich, but in that case the statement will not bear the slightest investigation. Dr. Petzholdt, in his excellent 'Handbuch der deutschen Bibliotheken,' gives the numbers thus, out of which the total is composed—

16,000	Manuscripts
13,000	Early printed Books
250,000	Printed *Works*
100,000	Dissertations
300,000	Pamphlets

These numbers added together give 679,000 only, but it will be observed that as one of the items is 250,000 *works*, it may be alleged that as there are so many works in two or twenty, or even a hundred volumes, the difference may thus be made up. Two of the other items however are 100,000 dissertations, and 300,000 pamphlets. Taking these at 40,000 volumes altogether, according to Balbi's rule, and deducting the 16,000 manuscripts, the library at Munich is at once reduced to 424,000 volumes.

The third, if not the second, great library in Europe is now that of the British Museum. In a previous article in this Cyclopædia [British Museum] some of the steps have been pointed out by which it has emerged to importance in the course of the last quarter of a century from a position of inferiority, not only to the libraries of Vienna and Berlin, but to those of Munich and Copenhagen. The number of volumes in the library was officially stated in 1858 at 550,000, and the numbers added since must have carried it over 600,000. These numbers are arrived at by counting the volumes as they come from the hands of the binder, not as they go to him; reckoning a pamphlet bound separately, however insignificant, as one volume, and also reckoning a three-volumed novel as one volume only, provided the three volumes are, as they generally are at the Museum, actually bound in one.

This system of counting is hardly satisfactory, for it makes the numbers vary in cases where the books remain the same. A volume of old pamphlets sent to the binder to be taken to pieces goes one volume and comes back a dozen, while 300 volumes of novels return shrunk to a hundred. If a congress of librarians were ever to take place in Europe, as it did a few years ago in America, one of the first things for them to settle would be the method of counting libraries. If every separate work under 100 pages were to be considered a pamphlet, if ten of such pamphlets were counted as one volume, and if in other cases the divisions made by the printer and not the binder were taken as a guide, a better comparison of the extent of libraries would be practicable, and the British Museum would probably be found to stand still higher than it now appears to do, even in point of numbers. The rank of a library, however, does not entirely depend on its number of volumes, however important an element that may be. The Zaluski library, though in 1789 it outnumbered that of the Kings of France, could not have approached it in point of value. The first book printed in English by Caxton, one of the treasures of the Museum, sold the last time a copy came to auction for over 1000*l.*, while a hundred thousand dissertations, now in the Advocates' Library at Edinburgh, were bought for less than a farthing each. There can be no doubt that in numbers, and also in intrinsic value, the hundred thousand dissertations far surpass the 'Recuyell of the historie of Troye,' but a library which aims at universality must aim at possessing both.

Under all circumstances, it appears remarkable that this idea of a complete or universal library, so long and so generally current, should never have approached to a more thorough realisation. Of all institutions of public magnificence, that of a great library is at the same time the most useful and the least expensive. A few years ago a single picture by Paul Veronese was bought for the National Gallery for 13,000*l.* The highest sum that has ever been voted by the House of Commons to the British Museum for the purchase of printed books for a whole year is 10,000*l.* There can be little doubt that if 10,000*l.* a-year had been voted uninterruptedly for the purchase of books for the last fifty years, and had been judiciously expended, the nation would now be in possession of the finest and completest library the world has ever seen, and perhaps of a finer and completer than the world will now ever see.

Such a library should, if anywhere, be in London. A great deal depends on the locality in which a library is placed. That of the kings of France was once kept at Blois, and for a long time afterwards at Fontainebleau. It was one of the good deeds of Henry IV. to remove it to Paris, and one of the good deeds of Louis XIV. to leave it there, instead of removing it to Versailles. The great library of England was for two centuries at Oxford, where it was founded amid universal acclamation in close neighbourhood to numerous college libraries, at a time when there was no public library whatever in the capital. Of all places in the world, London would appear to be the most appropriate for the seat of a great permanent and universal library. Talleyrand is reported to have said that Paris was the capital of Europe, and London the capital of the globe. No other capital stands in such direct and constant communication with all the ends of the earth,—no other has such a vast resident population,—and no other, except Paris, is visited by such an immense variety of strangers. An institution not far from its centre is within easy reach of two millions and a half of persons. Shielded by its sea from the Continent, England has for ages been the asylum of foreign refugees, and is the safest asylum in Europe for persecuted books. It is remarkable that while England is as distinguished for its opposition to centralisation, in many important respects, as France is for its attachment to that form of rule, the two countries exchange their characteristics in the very case in which the advantages of centralisation are the most capable of proof. Paris boasts of several public libraries, of which some are almost rivals of the principal; and a reader who wishes to study a particular language may possibly find the grammar of it in one collection, the dictionary in another, and the chrestomathy in a third. In London, the one great library of the British Museum towers above all rivalry since its important accessions of the last forty years; and while the first library of London has more than 600,000 volumes, the second has hardly one tenth of that number.

Even when a collection aims at universality, there are of course some points to which more importance will be attached than to others. In a national collection the first object should be the national literature. There is an admirable saying related of the Spanish poet, Moratin the elder, that when he was once asked by a young fellow-countryman what authors he should study, he replied, "Spanish and Greek, Spanish and Latin, Spanish and Italian, Spanish and French, Spanish and English." The spirit of the saying should serve as a guide to the librarian who is fortunate enough to have the selection of the purchases for a large national and universal library.

It has been already remarked, that owing to the altered circumstances of recent years some of the opportunities of forming a complete collection of valuable literature which have been allowed to escape, will probably never recur. It is to English literature in particular that this remark applies, and a glance at the history of the principal attempts to embody it in libraries will confirm the view.

At the time that the Bodleian library was founded at Oxford in 1602, there would have been little comparative difficulty in forming a complete collection of the literature of the English language. In the preceding century, during and after the struggles of the Reformation, many English books had been printed abroad, at first by the Reformers, and then after the Reformers' triumph, by the Catholics, but all of them had been intended for the market at home, and circulated here. Almost all the remaining literature of the language was issued at London, and by the members of the Stationers' Company, and the transfer to the Bodleian of the privilege of the Stationers to receive a copy of each book entered at their hall, seemed to ensure that a complete collection of English literature should in future exist. The brilliant prospects of the Bodleian in this respect were destroyed by the remarkable shortsightedness of the founder, Sir Thomas Bodley. "I can see no good reason," he wrote to the first librarian, Dr. James, "to alter my opinion for excluding such books as almanacks, plays, and an infinite number that are daily printed of very unworthy matters and handling, such as methinks both the keeper and under-keeper should disdain to seek out to deliver to any man. Haply some plays may be worth the keeping, but hardly one in forty. For it is not alike in English plays and others of other nations, because they are most esteemed for learning the languages, and many of them compiled by men of great fame for wisdom and learning, which is seldom or never here among us." Nothing can be added to the force of the simple remark that this passage was written by a contemporary of Shakspere. Of course the opinion of the librarian was obliged to bend to the will of the founder, and it would be difficult to estimate the damage that has been done to literature by this unfortunate decision of that illustrious man. For more than two centuries afterwards, it appears to have been the practice of the Bodleian librarians to sell or destroy such books as they judged unworthy of a place on their shelves, and this unhappy example was followed in other libraries. In Hyde's catalogue of the Bodleian, published in 1674, the only collection of Shakspere's plays is the folio of 1664; and the only separate play is a 'Hamlet,' published after the Restoration. Though the dramatist was known to be the favourite of "Eliza and our James," and also of King Charles, who held court at Oxford, neither the first nor the second folio was deemed worthy of a place on the shelves of the University. But when, more than a century afterwards, the tide had so changed that one of the chief glories of the Bodleian was in the Malone library of Shaksperian literature, presented to the University by his brother; and when, in 1841, Marlowe's play of the 'Contention of the Houses of York and Lancaster,' a single one of the mass rejected by Bodley, was bought by the Bodleian library for 131*l.*, a lesson was read which ought to sink deeply into the minds, not only of the Bodleian, but all other librarians.

A complete contrast to Sir Thomas Bodley was presented by one who was probably his contemporary for a part of his life, George Thomason, a bookseller of St. Paul's churchyard, who at the commencement of the great civil strife in 1640, was struck with the happy idea of collecting every publication and pamphlet that appeared on both sides in that memorable contest; and with unshaken constancy, and at immense expense and trouble, carried out his project till the Restoration in 1660. His enterprise was less prudent than patriotic, for his hopes appear to have been to dispose of, not to retain the collection, and the Restoration left him but two probable purchasers, in the Bodleian library and the king; though it could hardly be expected that the university would wish to recall the downfall of the church, or the monarch the downfall of the monarchy. The university, however, only declined on the ground of want of funds; and the king actually purchased but would never pay, so that Thomason's representatives, who had at first been glad to be quit of the burden, were glad to receive it back. After the lapse of a century the collection was finally purchased by George III., and presented to the British Museum, where it still remains, a library in itself, often consulted for various purposes, but never as yet thoroughly explored. Thomason was fortunate in the time and country of his enterprise. The contemporary French collectors of 'Mazarinades,' as they were called, or the innumerable pamphlets against Cardinal Mazarin, amassed what was comparatively worthless. He was less fortunate in another respect, for while their collections have found a special historiographer to describe them, Thomason's still awaits one, and his name has never yet received the measure of honour which is its due.

For the remainder of the 17th century and for the earlier half of the 18th, the Bodleian continued the only library of national importance. The taste for private libraries arose and flourished, and one among them was remarkable for containing an immense assemblage of pamphlets, which might well have been made the foundation of a national collection. It may be supposed that the number of 350,000, which has been mentioned as that of the pamphlets, English and foreign, in the Harleian library, was much exaggerated, but there can be no doubt that a great and perhaps irreparable loss to literature was sustained, when that collection was allowed to be dispersed in 1741. Twelve years after, by the fortunate will of Sir Hans Sloane, and the fortunate acceptance of its provisions by the legislature (in case of whose refusal the library and museum were to be offered to St. Petersburg), a great library was at length, after more than one project had proved abortive, founded in London. The presentation to it by George II. of the library of the kings of England at once stamped it as national: but it was not till the presentation of another royal library, seventy years later, that of George III., by George IV., in 1823, that the Museum collection took the first rank among the libraries of England.

The time of the foundation of the Museum was only later by a few years than the time in which any general attention was first attracted abroad to English literature. In Holland indeed, for a full century previous, owing to commercial and political connection of the two countries, our language had been frequently studied, and in Germany and the north, theologians and scholars had occasionally mastered it for their purposes, but it was in Western Europe almost unknown. Garnier, a French Jesuit, who published a method of the arrangement of libraries in 1678, gave no directions respecting English books, because, as he observed, English books seldom crossed the sea. It was not till the memorable visit of Voltaire to England that a knowledge of the language and literature was introduced into France, and the study became so general, that Mr. Buckle in his 'History of Civilisation,' gives a list of more than a hundred and fifty French authors who are recorded to have had a knowledge of English. The English collector however found no competitors in foreign bibliographers for the purchase of rare and curious English books. The few specimens of the press of Caxton, some of them rare and curious, that are to be found on the continent, are in general those which he printed abroad in French, before he introduced the art into England. Of early English bibles, Christopher Anderson reports in his 'Annals,' that he found but a scanty provision in the great library of Paris, and it may be doubted if in all the continent half a dozen specimens exist of a quarto Elizabethan play. If the library of the Museum had then been provided with funds for the purpose, a good opportunity existed for many years of furnishing it with an excellent collection of English literature at a moderate expense. Books did not begin to fetch high prices till the sale of Dr. Askew's library in 1775, and then the general run was on classics or works of foreign literature.

That opportunity was lost, when soon after the commencement of the 19th century, the "bibliomania" awoke in England, and one of its most frequent forms was the craving for early English literature, to be gratified at any cost. During the early years of the century, at the times of the sale by auction of the library of the Duke of Roxburghe, and the foundation of the Roxburghe club, to commemorate the enormous price that was given there for an edition of Boccaccio's 'Decameron,' the competition at public sales was almost entirely between private purchasers, and the British Museum took no part in it. Few of the books that were sold in those years went out of England; they mostly passed into the hands of collectors, at whose death it was expected that they would again come under the hammer of the auctioneer; and the varying prices of even the most coveted books showed the expediency of waiting in many cases till the fever of the day was over. The Roxburghe copy of the 'Valdarfer Boccaccio' itself, which had gone at the sale for 2260*l.*, sold for less than 1000*l.*, when it was a second time in the market, and the early editions of the classics, about which the contest was then carried on most warmly, have since descended considerably in the scale of commercial value. With many other bibliographical rarities, however, the market has risen; and it has risen most remarkably in English books of almost every character of the date of the 16th century, and in foreign books, such as Roman Catholic liturgies, connected with the history of the old religion, and of the Reformation in England. Another, and a world-wide influence was next to come into operation, to raise, in the language of political economy, first the supply of English books, and then the demand for them—an influence which will probably work as great a change in the commerce of books as in that of cotton.

A hundred years ago, at the accession of George III. in 1760, the English language is supposed to have been spoken by about twelve millions of persons. In the year 1860 it is probably spoken by not less than sixty millions, and each year adds to the census of those who speak it a number as great as the whole population of those who speak some of the secondary languages of Europe. The French and German languages, which at the commencement of the century far surpassed it in that respect, are now far below it. Russia is the only form of speech in Europe that owns at present a larger number of speakers, having about sixty-five millions; and if the advance of population continues for a few years as before, Russian will be outnumbered. The English language is at the same time the vernacular of a great kingdom in Europe, and of great colonies in America, in South Africa, and in Australia, all of which are growing and some are rushing into importance. But the dominion of the English language is not bounded by the limits of the British empire, wide as they are. It is also the language of a great republic, or rather cluster of republics, whose territories now extend from the Atlantic to the Pacific, and will probably in the course of another century be teeming with population. English is now spoken by more persons out of Europe than within it, and the disproportion is certain to grow greater every year. While in Old England it has yet been unable to supplant the Welsh in the course of centuries, in New England it has long swept from before it all trace of the languages of the aboriginal nations, except the books that were written for them by the missionaries of the 17th century.

This bond of community of language, which is often invoked in continental Europe as naturally leading to a community of government, did not prevent the Americans from commencing a war, in which they aimed at rendering themselves as completely independent of England as they were of France. Their political independence was secured by the treaty of 1783. For about forty years after, however, some of their ultra-patriotic writers were in the habit of complaining that their literary dependence was as great as ever, while at the same time, it was almost made a subject of national complaint, that a writer in one of the English reviews had inquired, "Who reads an American book?"

When American writers of remarkable merit really began to appear, their merit often found its warmest and sometimes earliest welcome in England, where the names of Irving and Cooper, Bryant and Longfellow, Prescott and Ticknor, Lucretia Davidson and Mrs. Stowe, are held in honour, not inferior to that which is paid to them in their own country. Irving and Bryant are the only two of these whose writings date back before 1820, and the reputation of Irving, as well as of Cooper, was powerfully aided by the voice of England. The truth is, that when the question was put "Who reads an American book?" no one either in England or America could clearly foresee the rapid development that was to take place in American literature, a phenomenon as striking in the field of literature as its political development in that of politics. The 18th and 19th centuries had been remarkable in Europe for the number of old established languages which had, after a long period of barrenness, at length burst into literary fertility. Before 1750 it might have been inquired with some truth, "Who reads a German book?" and the highest names in the latter half of the century were those of German authors. After the signal success of German, five or six other languages had emerged into an importance altogether undreamed of a century ago; but in every case of a fresh literature there had been a fresh language associated with it. As in North America the first example was given of one of the colonies of Europe rapidly emerging into a new and powerful state, so in North America the first instance occurred of one of the old languages of Europe giving birth to a new and important literature. The Spanish and Portuguese colonies, long anterior in date to the English, followed the Anglo-American example in one case, as they will do apparently in the other.

The circumstance of two literatures flourishing together in the same language is in an eminent degree fortunate for both. National prejudices are necessarily weakened, circumscribed ideas are necessarily widened, even by the mere enlargement of the literary horizon which is thus created. The sympathies of those who can read Dante and Schiller are not likely to be cold towards Italy and Germany; but how limited a number of English readers can be expected to master German and Italian, how different is the effect of reading a poet in the translation or the original. The American can enjoy every word of Shakspere and Byron; the Englishman, of Bryant and Longfellow. When America had scarcely a writer of its own, its readers had access to the rich treasures of English literature, and educated by that knowledge, its authors, when they came forward to contest the palm, stood on equal ground with those they had to encounter. A hundred and fifty miles from London there was in the meantime a Welsh population to whom Shakspere and Byron were idle names.

The sudden rise and rapid progress of American literature made it necessary for any library, intended to embrace the whole wealth of the English language, to extend its plan and enlarge its sphere. Popular as many books of American origin became in England, to such an extent in fact that many of them formed part of the ordinary stock of booksellers' shops in country towns, it was chiefly through reprints that they circulated; and there were hundreds of volumes published in the United States of which probably not one copy was sent for sale to England. Histories of American country towns, genealogies of American families, biographies of American local celebrities, reports of American legal decisions, and so on, are books for which few, men can find space in their libraries; but it is easy to see how to be able to consult a copy of such books, in particular cases, may be all-important to particular persons, and is always of value to those who compile or who cater for the public. An American genealogy will often throw light on the history of an English family; an American law-case may involve the acquisition or loss of property to English residents; the historian of the contests between England and America, or of our religious sects, or of our arts and manufactures, may often find something in American topography or biography bearing on his subject; to say nothing of the general interest attaching for its own sake to a nation so conspicuous in the eyes of the present world, and so important in all speculations of the future. This object has not been lost sight of by those who have had the selection of books for purchase for the British Museum; and indeed it is the opinion of competent judges that a more complete collection of American literature has been amassed there in the course of the last twenty years, than exists in any library of the United States.

The marked success of America, in literature, of course encourages the confident hope, already justified by more than one brilliant example, that other communities sprung from the English stock will, when the first cares of colonisation and settlement are over, give equal proofs of literary ambition and literary powers. In the meantime the productions of British America and Australia have already a strong historical value of their own, and are certain to derive an additional interest as the communities to which they belong advance in prosperity and importance. The collection of their different productions in one vast library would present a spectacle of interest to the whole world, of surpassing interest and pride to all who belong to what has been called the Anglo-Saxon race, whose triumphs in the field of literature are at least as noble as in any other.

The American movement in literature was followed by a movement on that side of the Atlantic, still more unexpected on this, and which indeed might well take Europe by surprise. The libraries of the provinces now forming the United States had received, previous to the declaration of independence, no scanty contributions from English liberality. After the war of the revolution there was a time in the new commonwealth when public libraries attracted little of the public attention. Dr. Channing, in a discourse in 1836, spoke of the Redwood library, at Newport, Rhode Island, as "yonder beautiful edifice, now so frequented and so useful as a public library, but once so deserted that I spent day after day, and sometimes week after week, amidst its dusty volumes without interruption from a single visitor." This state of affairs has been completely changed in the course of the last forty years, the movement proceeding with accelerated rapidity, in the last thirty, the last twenty, and the last ten. Numerous collectors have appeared who have expended large sums of money in the purchase of libraries of standard European, but more particularly of standard English, literature, and more especially of books relating, however remotely, to America. Some of these collections have been since dispersed on the death of their possessors, and some have even returned for sale to England. But several have been presented to public libraries, and others, which have been amassed at large expense, have been collected with the expressed intention of bequeathing them to public use. The subscription libraries of America, of which the first was founded at Philadelphia, by Franklin, in 1731, have grown numerous, and been remarkably supported by donations of money from individual members. On more than one occasion agents have been sent to Europe with thousands of pounds, supplied from private funds, to be expended in the purchase of books for public libraries; and on whole libraries occurring for sale in Europe, an individual has advanced the money to acquire them in a mass, and present them in a mass to some public collection. The "State Libraries" belonging to several of the states have, at the same time, been largely augmented at the public expense. A library of 80,000 volumes was collected in about four years, and has been opened to the public in New York, on the foundation of Mr. Astor, a German merchant, who made his fortune in America, and by the donations of his equally public-spirited son. Congress appropriated a sum of more than 100,000*l*., left to the United States "for the increase and diffusion of knowledge among men," to the foundation of an establishment called the Smithsonian Institution, of which a library was to form a leading feature. In Massachusetts, a law was passed, in 1850, for the foundation of libraries in towns, and one has been set on foot and opened in Boston which has been assisted by munificent donations, and keeps agents constantly employed in Europe. Two American writers, who have each published a volume of statistics on the subject, have thrown over it a somewhat ludicrous air, by giving the name of public libraries to the collections of books belonging to Sunday-schools and common schools, often of less than a hundred volumes, to which an Englishman would as little think of seriously applying the term as to our common circulating libraries, or the collections in our coffee-shops. Professor Jewett, in 1850, thus states the number of public libraries in the United States as 10,199, and the volumes in them as 3,753,964; and Mr. Rhees, in 1859, raises the number of public libraries to 50,890, containing 12,720,686 volumes. Striking off at a blow 48,000 of these public libraries, of which 30,000 belong to Sunday-schools, and 18,000 to common schools, the remainder will still excite our surprise. The effect of their existence has been to send an American agent to almost every important sale of books that occurs in England, and to every bookseller's shop, and to raise considerably the price of standard English literature not of the present day.

A movement analogous to that in America has already developed itself at an English colony in Australia, in which the rapid wealth flowing from gold-digging has been turned to the creation of libraries as well as railways. In the city of Melbourne, in the province of Victoria, founded in 1837, there are already a library of the Supreme Court, a library of the University, a library of the Legislature, and finally, a public library, supported at the public expense, founded in 1856, and counting in 1859, 25,000 volumes. At Sydney there is also a university with its library, and we have already heard of Caxtons that have been recently purchased in London, whose ultimate destination is a public library at the Antipodes.

These movements do honour to all who take part in them, and cannot be viewed by an English lover of books and literature without feelings of the warmest sympathy and admiration—not unmingled with a wish that the example they display may soon be followed in countries where perhaps it ought to have been set. These sentiments of gratification would be unmingled if, in Great Britain and Ireland, there were two or three libraries possessed of a complete collection of English literature. It is unfortunately the case that as yet there is not one. The danger is therefore evident that, under these circumstances, such a collection may possibly never exist—that such of our books as are unique, or only extant in a small number of copies, and are not yet secured in our public libraries, may be lost to them for ever. The first edition of the 'Pilgrim's Progress,' which differs considerably from the second, is now so scarce that Macaulay, in his life of Bunyan, speaks of it as no longer extant, and in fact only two copies are known to exist. Were one of these in the library of the British Museum we might not only hear with indifference, but with pleasure, that the other is at New York.

It is quite possible that, ere many years are over, an English scholar, who is in search of a rare English book, may be referred for it, not to Oxford or to Althorpe, but to Washington, or San Francisco, or the Antipodes. When, less than twenty years ago, the increased grant was given to the library of the British Museum, it was not given a moment too early, and on the liberality of the House of Commons to the Museum for the next twenty years, and the way in which that liberality is made use of, it will probably depend whether an English library, such as might have been collected with comparative ease at the beginning of the century, shall ever exist at all. That it should exist is the interest of all who enjoy the common inheritance—the English language, no less than the interest of the English nation.

In speaking of collections of books, the word "books" may be used in a limited or an extended sense. A pamphlet is scarcely considered, in common usage, entitled to be called a book. It would be thought by many that a complete collection of English literature had been formed when the jurisprudential department was such as may be found at our Inns of Court; the medical, such as exists in the College of Surgeons; the Church of England theology, such as at Sion College; and so on, going through all departments. A collection resembling this was probably contemplated by Sir Thomas Bodley, and in rejecting plays he assumed, as we have seen, that he was only rejecting trash. All men now smile at his error, because we find that in so doing he rejected the plays of Shakspere, but many who smile would fully agree with more recent curators of the Bodleian in rejecting novels. In fact, there was no public library in England in which such works were admitted, at the beginning of the present century, and the bibliomaniacs who gave high prices for Lodge's 'Rosalind,' and Lilly's 'Euphues,' would probably have looked on the proposal to collect the novels of Mrs. Radcliffe or Charlotte Smith with ineffable scorn. Even now the new school of bibliographers is probably in a minority, which maintains that books like these should be carefully collected, preserved, and catalogued. The grounds upon which they rest are several. These books are generally very short-lived. Nothing is so difficult to find, if it happen to be wanted, as a novel that was in everybody's hands some years ago, for being in everybody's hands it was the more liable and likely to be pulled to pieces. About thirty years after its publication, a search for the first edition of 'Waverley' was long ineffectual, till a copy turned up in private hands. We have been told that at the library of the British Museum, a collection of old novels of a certain period was long a desideratum, till about fourteen hundred volumes appeared in an auction, catalogued without specification as "Old Novels," in lots of forty volumes each, and were bought for the Museum at less than a penny a volume, probably the cheapest purchase ever made for the national library. The best novels are now admitted to form one of the very best portions of English literature. Of the 'Vicar of Wakefield' and of 'Waverley,' few will deny that the national library should contain the early editions, those that passed under the author's revision, and those which present peculiar characteristics, special illustrations or special notes. After such books as these there come hundreds of novels of the second, and thousands of the third class—stories which have had their season, which have been read with interest, laid aside and forgotten,—but some of which after being nearly forgotten have revived again, and have been discovered to possess merit greater than was at first imagined. Novels have been for the last fifty years, at least, the field in which most of the genius that was formerly devoted to the drama has sought its exercise, and it was the opinion of Sir Walter Scott that that field was rich indeed in buried treasure. It is to novels in fact that most of us owe our knowledge of the forms of life around us with which we do not come in immediate contact—it is in them that the lawyer can study the life of a man-of-war, and the midshipman that of a country parsonage or a cathedral town. The time may come when future generations will look back to the English novels of our own time with as ineffectual emulation as our generation on the drama of the Elizabethan age. But in regard even to volumes of which the merit is not discernible, the new bibliographic school is at variance with the old. It contends that while it is one part of the purpose of a great public library to preserve a copy of every book that people take pains to collect on account of its value, it should be another part of its purpose to preserve a copy of the books which nobody takes pains to collect, because they are therefore almost certain to disappear. There is no knowing beforehand what adventitious interest may come to attach to a book from particular circumstances. Anonymous novels and romances of no intrinsic merit cannot but wear a different aspect in our eyes when they are known to have been written by Theodore Hook or Shelley, as a commonplace anonymous review of Wordsworth in an old magazine is scanned with an attention its merits little deserve when discovered to be by Byron at college. In all the minute biographies of our recent great authors—in those of Byron, Walter Scott, Moore, Southey, Wordsworth—the reader finds indications of this kind which invest with interest books and fragments that he might have been previously inclined to pass without notice.

If the arguments of the new school are allowed to be valid in the case of "trash," they are certainly not less forcible with regard to "lumber," of which they no less warmly advocate the collection and preservation. Perhaps the shortest method of arriving at a clear view on the subject of "lumber" will be to examine the bearings of a particular case.

The 'Times' newspaper is the most effectual organ of publicity that now exists, or has ever existed in England. On the day of its publication, an article likely to interest the Queen will probably meet the eye of the Queen,—an article touching on the law will be scanned by the bench and bar; a paragraph on public houses will come under the notice of twenty thousand licensed victuallers. Myriads of copies are read by hundreds of thousands of readers at the places of public resort. On the day after its publication it has passed into comparative obscurity; in the week after it is difficult to procure a copy if one is wanted for a particular purpose; in the month after, it can only be consulted at particular places; in a twelvemonth after, of the myriad copies that have been issued, how many remain? The great majority of its readers have done with it for ever on the day of its publication; few private individuals think of preserving it, and those few soon discover that the task is more burdensome than they supposed, that it involves expense and trouble which are continually increasing, and that merely to find room for the volumes is an oppressive tax. Even in coffee-houses and other places where customers are attracted by the announcement that files of newspapers are kept, it is the general practice to destroy them at the end of about ten years, lest the accumulation should drive the accumulator out of house and home. Nothing of a literary kind attracts more universally the reproach conveyed in the appellation "lumber" than the files of an old newspaper. The natural results follow. The most insignificant book of which twenty copies are printed is almost certain to be in existence somewhere at the end of twenty years, but it is quite possible that in the course of that time every copy of one day's edition of the most widely circulated newspaper in Europe may be consigned to destruction. There are numerous reasons why the disappearance of nine hundred and ninety-nine out of a thousand copies of the 'Times' should be looked on without any disfavour whatever, as in fact equally natural and necessary, but there are also numerous reasons why the thousandth should be preserved. It is a record, the possible importance of which can hardly be overrated. The persons who have to consult a set of the 'Times' for a particular piece of information—and who may not suddenly require to consult it?—for an advertisement for next of kin, for the record of some long past marriage or death—may, if a single number be wanting in a set, throw away all the tedious labour of hunting through the ponderous volumes of years. An old number is sometimes in request for literary purposes. An anecdote told in 'Moore's Diary,' that a poetical *jeu d'esprit* in a number of the 'Times,' at the period of the Reform Bill, was attributed at Rogers's breakfast-table to Moore, and on being denied by him was acknowledged by Macaulay, has led, since Lord Macaulay's death, to a search after the forgotten poem in the set of the 'Times' at the British Museum, to be transferred from the unwieldy columns to a place in the posthumous works of its illustrious author, which will find their way in some edition to almost every library in Christendom. If it be granted that it is desirable that a complete set of the 'Times' should exist, it can hardly be doubted that it is desirable it should exist in a public library. Such a set in the possession of a private individual could not well be made available for one-half of its proper purposes, even if with the most transcendant good-nature he should be willing to entertain at his own expense every application made to him. There must not only be the store-rooms or cellars to place it in —and there are now twelve folio volumes a year—but the room to examine it in, the large strong tables to place it on, the attendants to bring and remove the volumes, as they are wanted or done with. But does such a set exist either at the British Museum, the 'Times' office, or elsewhere? It is no part of the general economy of newspaper offices in London to take such things into account. At the office of the 'Morning Chronicle,' which is one of the oldest London papers, there is no set of the 'Morning Chronicle,' and at the office of the 'Daily Telegraph,' which is one of the newest, there is no set of the 'Daily Telegraph.'

Supposing the set to be imperfect at a public library and pains taken to complete it, how thorough an illustration would the process probably afford of the usual joys and sorrows of the management of a library? In such cases catalogues have to be searched to ascertain when any volumes of the 'Times' will occur for sale; when they do, attention is to be given to procure the information, often not easy to be obtained, if "with all faults and errors of description," they really contain the missing numbers. Care must be taken not to let it be known too widely that the numbers are wanted, lest some bookseller should take advantage of the knowledge to secure them for himself, or run up the price. Even under the most favourable circumstances the price may accidentally ascend so high that the librarian may doubt if he is justified in expending the money in the purchase; and those who think his proceedings worth notice, without understanding them, may criticise him for the extravagant style in which he wastes the public money. When the numbers are secured,—when finally the set is thoroughly complete—comes the tedious task of the incorporation of the new acquisitions, the disposal of the duplicates that have in all probability been necessarily acquired, and the crowning joy of the alteration of the entry in the catalogue from "'The Times' from 1788 to 1859, wanting such and such numbers," to the simplicity of "'The Times' from 1788 to 1859 complete." When this consummation is achieved, the librarian's toils are naturally forgotten, and every subsequent reader assumes, as a matter of course, that the volumes, to use an expressive phrase, "grew on the shelves." It is well for the librarian if the history terminates here; but the annals of the British Museum inform us that some years ago a writer, admitted to all the privileges of that magnificent institution, being engaged in writing a life of Daniel O'Connell, for which he required some extracts from the newspapers, took his penknife instead of his pen, and to save himself the trouble of copying a few paragraphs, deliberately mutilated every volume of newspapers that was brought for his use. A man of this description may in a few days of undetected villany ruin the labours of years, and defraud centuries to come. Sets of the 'Times,' it may be observed, are evidently rising in the market. The library of the State of New York has acquired a set, though not a complete one; and we have heard, on good authority, that 1000*l.* would be given for a perfect set for the library of Melbourne.

Of course the argument in favour of the 'Times' will extend to many other of the London papers. The British Museum now receives and preserves them all, and in addition, all the English country papers, all the Scotch, and all the Irish. In the Museum returns for 1860, it is reported that in 1859, 584 were received from England, 113 from Ireland, and 125 from Scotland. They are sent from the Stamp Office, not at the time of publication, but a few years after; and they are attended to with the utmost care, bound and kept ready for instantaneous reference. A new use of them has lately been developed. An excellent example has been set in some of the northern counties of England, of publishing 'Local Records,' in which all the really memorable occurrences that have taken place in a particular district for about a century, are condensed from a hundred folio volumes of the local newspapers, into the compass of one or two octavos, easy of reference and abundant in interest to the resident or visitor of the different localities. If this practice spread, as it appears likely to do, the vaults of the British Museum will furnish matter for many a volume that will be popular at the fireside, and that must otherwise have remained unwritten. A still wider interest must attach to the annals of English colonies, than to those of English counties; and there can be little doubt that the prosperous communities of future times will look back to the struggles of their early period as mirrored in their contemporary records, with an interest akin to that felt by the grown man in the reminiscences of his childhood. It is to be regretted that, as yet, little has been done in this direction in the Museum Library. Unless current reports are ill-founded, a great statesman, who was also a

Trustee of the Museum, no less a man than Sir Robert Peel, who had himself been Colonial Secretary, once interposed his veto to prevent the innovation of collecting colonial newspapers. Neither at the Museum nor at the East India House, is there a collection of the English newspapers published in India, though at the India House a collection of the native newspapers was procured at the suggestion of the late librarian, Professor Wilson, the eminent Sanscrit scholar. A plan for collecting sets of *all* the American newspapers has never, we believe, been seriously entertained, the notion of assembling them too nearly approaches that formerly advocated by Dr. Anderson, of Glasgow, the ingenious editor of the 'Bee,' who wished to collect and preserve everything whatever in print—every shop-bill, every placard for a lost article, issued throughout Great Britain. The number is now estimated to be upwards of 4000. Sets of the leading American newspapers are of course desirable for the rest. An ingenious idea, put in practice by Mr. Charles Knight some years ago, with regard to the lower periodicals of London, would seem to be the most advisable plan to adopt with these multitudinous journals. He sent round on a particular day to collect one specimen of every periodical sheet that issued from the press on that day or nearest to it, and was thus enabled to draw conclusions as to the character and tendency of the whole body of contemporary periodical literature. A collection of the first number of every American newspaper and periodical issued in 1861, would be an interesting and a suggestive exhibition.

The same arguments that hold good for the preservation of newspapers, apply, and sometimes with additional force, to other varieties of transient literature—to that most ancient and most despised species of periodical publication the Almanack—to the Directory, of which the annihilation is carried on with such vigour, that it may be questioned if a complete set of the 'London Directory' exists in London. But even in the most respected forms of periodical publication, the long continuance of their success, in point of time, renders their presence onerous in point of space. As no English newspaper has, like some of its Dutch, German, and Swedish contemporaries, lasted over two hundred years, so no English magazine has, like the French 'Mercure,' ever extended to more than a thousand volumes; but the sets of the 'Monthly Review,' and the 'Critical Review,' and the 'Universal Magazine,' and the 'Scot's Magazine,' to mention none but those which are defunct, are too voluminous each of them for libraries of ordinary size, while the combination of all of them, and of hundreds more, in some one locality, is as necessary for use as it is difficult of accomplishment. In fine, all those who have had experience of making research in any department of knowledge whatever, have found reason to complain that the stores of English literature in the British Museum, ample as they seem, and as in many respects they are, are still too scanty by far, and that much that is attainable remains to be attained.

The English is not the only language of the British Islands; and apart from the interest which must always attach to the Welsh as the early speech of at least part of the country before an Anglo-Saxon set foot on its soil, that language may claim to be one of the oldest of modern Europe, and it has been cultivated to a high pitch of refinement by a small community, overborne by an overwhelmingly powerful neighbour. It is singular that the literary cultivation of the country has never developed itself in the direction of bibliographical collections; for the concentrated diligence of a few years, combined with a moderately liberal expenditure, would probably have sufficed to assemble a complete collection of Welsh printed literature, the possession of which might have conferred celebrity on a local society or a local magnate. Nothing of the kind appears to have been done on a scale approaching completeness; and the largest Welsh collection now known is that of the British Museum, with which the scanty libraries formerly belonging to the Welsh School, and the Cymmrodorion Society, have been incorporated. So little does its existence appear to be known in Wales, that we find, in the 'Life of the Rev. Thomas Price,' an eminent Welsh scholar, some bitter complaints of the total neglect of Welsh literature at the British Museum, at a time when more attention was paid to it there than anywhere else. Compared with Welsh, the literature of Gaelic and Irish is excessively scanty; but Gaelic has to boast of one name, Ossian, which is famous throughout Christendom, though the Gaelic poems printed under his name are of course no more genuine than the English so-called translations, which are in reality the originals. The best collection of books in Irish is in the Grenville library at the British Museum, amid probably as extensive a collection of Irish books in English as is anywhere to be found; but both Gaelic and Irish are languages to which more attention might be paid with advantage. There is a complete bibliography of Gaelic books in Reid's 'Bibliotheca Scoto-Celtica,' which might serve as a guide for collecting them.

In every great public library formed with a view of affording means for the acquisition of sound and substantial knowledge, the foreign books will far outnumber the native. One of the so-called dead languages was for ages after its death the language of all living literary Europe, and the treasures contained in it are in consequence remarkable for quantity as well as for quality. Since the revival of literature, though different languages have predominated at different times, and some which have shone have had intervals of obscurity, the number of languages in active cultivation has constantly been on the increase. After the invention of printing, Italian was the first vernacular language to produce works of remarkable genius, and even before the invention of printing it had already had a time of flourishing and a time of decay. Spain followed, in the age of Charles V. Towards the close of the 16th century England had its Elizabethan age. The 17th century produced Richelieu and Louis XIV. for France. It was Richelieu who first definitively formed the project of the dethronement of Latin as the general language of serious learning, and the establishment of French in its place. His plans had singular success for a period, and French is still the most general medium of intercourse in Europe; but the great effect has been, not the introduction of a living language in the place of the dead one, but the general adoption of each living language as a literary medium by those who speak it. This system has been becoming more and more general since about the year 1750, when the Germans may be said to have abandoned Latin for German. At present there are at least six European languages in cultivation—Danish, Swedish, Russian, Polish, Bohemian, Hungarian—which a century ago might have been neglected with impunity by the literary student. Russian might always have been expected to rise into importance as the plans of Peter the Great took effect; but Bohemian and Hungarian were then regarded, even by those who spoke them, as likely to pass away in a course of gradual decay.

It may be of advantage to take a rapid survey of all these literatures in succession, with a view of ascertaining what large collections of them have been formed, either on their own soil or in the great libraries of Europe, and more especially in that of England.

The three dead languages which have been the great objects of study had, till the recent revival of the separate kingdom of Greece, no particular spot where they might claim in modern times a "local habitation and a name." The literature of the Hebrew language has been, like the Hebrew nation, scattered over the world. A language which has been dead since the Babylonian captivity, which had long ceased to be spoken when the New Testament was written, is cultivated with sufficient energy in the 19th century to supply materials for a modern bibliographical periodical, published at Berlin—the 'Hebräische Bibliographie.' The first book printed in Portugal, and the first book printed in Turkey, was a Hebrew Pentateuch, and it was probably also the first printed in several Mohammedan countries, where the art was permitted for the reproduction of the Bible, though forbidden for the reproduction of the Koran. Jewish literature is not, however, confined to comments on the Bible, and is of far more extent than has often been supposed. Mr. Wilson Croker, on his examination before the royal commissioners on the British Museum, expressed his belief that there were no books in print exclusively Hebrew without a Latin explanation of some sort. There were at the time more than 4000 of that description in the British Museum, comprising not only editions of the Bible and commentaries, but Jewish plays and Jewish epics. The fate of Jewish libraries has been singular. The two largest now in existence are said to be those formed by Rabbi David Oppenheimer in the 17th century, and by Mr. Michael of Hamburg in the 19th, of which the first and largest is now in the Bodleian library, and the second in the British Museum. Formed in Germany, and both preserved at Hamburg, they have both been transferred to England, and Oxford is now become in particular the place of pilgrimage to Jewish bibliographers. The collection at the Museum is being constantly augmented with accessions from quarters from which no other accessions come—from presses in the Crimea, among the Karaites, from obscure villages in Russian Poland, from Africa, and from Turkey. The number of volumes in the Museum collection was stated by its librarian, Mr. Zedner, in the 'Hebräische Bibliographie' for 1859, to be 7480.

Still more full of life than the Hebrew is the Greek literature, tracing its illustrious course through the long ages from the foundation of the first public library in Europe by Pisistratus at Athens, before the war with Xerxes, to the foundation of the library of the university of Athens in our own time, after the rescue of Greece from the Turkish yoke. Till the 19th century few Greek books could be printed on the soil of Greece, and those few were in the modern Greek—a language into which the 'Iliad' itself had been translated before the fall of Constantinople. Of the books printed in ancient Greek in different parts of Europe in the four previous centuries, there are many good collections extant. These books were always esteemed of value; they were eagerly sought after for great libraries at an early period; in the 18th century they brought high prices from scholars and bibliomaniacs, and were looked upon as the choicest of the early productions of the art of printing. There is an excellent collection of them in the British Museum. There is in the same library a collection, less valuable and more rare, of books in modern Greek, brought together by Lord Guildford, the warm friend of the Greeks and founder of the university of Corfu. When his library was sold, at his death, this collection was acquired in a mass by the Museum; and though it is by no means complete, it contains perhaps more than any other of the works described in the bibliography of Iken and Papadopulos. These books are curious for tracing the history of the backward stages of the modern language, which has been becoming every year more and more ancient.

An immense and important portion of every library worthy of the name must be formed by works in the Latin language. By those who declaim against the study of Latin, as a sacrifice of valuable time to the acquisition of a mere knowledge of the literature of the heathen

Romans, it appears to be forgotten that Latin was for about fifteen centuries the language most intimately connected with the history of our own country, as well as of many others. It was in Latin that Cæsar wrote his account of the discovery of Britain; in Latin that the Saxon Bede composed his valuable history of the English church; in Latin that the monkish chroniclers, Saxon, Norman, and English, compiled their records of contemporary events for century after century. It was the same with France, with Italy, with Spain, with Germany, with Scandinavia. In Poland and Hungary and Holland the usage of Latin continued still later, and the parliamentary speeches of Hungarian magnates almost up to our own times, and the lectures of Dutch professors even now are delivered in the language of Cicero and Cæsar. The early productions of printing were mostly in Latin, and for long afterwards the appearance of literary Europe was that of a learned republic, in which Latin was the predominant speech, and the modern languages merely took the position of provincial dialects. The libraries of mark throughout Europe were chiefly filled with Latin, and it might almost have been expected that the happy idea would have occurred to some great potentate to collect together all the Latin books that kept pouring from the press in the different parts of Europe. It was towards the close of the 15th century that King Matthias Corvinus, of Hungary, applied himself to the task of collecting a magnificent library, for which his expenses were truly regal, amounting according to some, to 30,000 florins a-year. He is said to have kept thirty copyists constantly employed; and at his death, in 1490, his collection is stated to have amounted to nearly 55,000 volumes, "almost all manuscripts." Had this expenditure been recorded of a monarch who died in 1390, or before the invention of printing, our admiration might have been excited in a high degree, but it awakens wonder that admiration should be claimed for a monarch who expended treasures in multiplying manuscripts after he had himself invited the first printer to Buda. The proceedings of King Matthias, however, are still pointed to by some modern writers with unalloyed panegyric. When the collecting of books first came into fashion, the early printed Greek and Latin volumes were those most sought after, and large collections were made of "incunables," or "cradle-books," as those are technically called which were issued in the infancy or cradle-times of printing. The first editions of the classics, however, were those which attracted the most attention, and other works of the 15th century were comparatively neglected. In Panzer's valuable catalogue of the books printed before 1535, a work which, including the German part, extends to thirteen quarto volumes, he is obliged to refer to numerous libraries as the depositaries of the various treasures which he describes from numerous catalogues. There is no library in Europe which approaches to containing them all. Yet there are still floating about Europe so many copies of volumes of the period referred to, not only for sale, but often for sale at very moderate prices, that the steady adherence of a well-provided library for some years to the rule which has, it is said, been adopted by some, of buying every work not in its possession printed before 1500, would probably have a very considerable effect. Four hundred years, and more, have not cleared from the booksellers' shelves the copies of many books which were only printed, it is said, in editions of less than five hundred copies: but here again it is more than probable that the next fifty years will effect more than all their predecessors have done.

After the literature of the language of ancient Italy, that of the language of modern Italy appears to have entered the earliest into general circulation. In the days of Elizabeth and the early Stuarts, a knowledge of Italian was more common in England than it has ever been since, and for part of the time it was the popular language of the court of France, which was as usual governed by female influence, and was then under the guidance of Italian princesses. There has therefore always been a tendency for Italian books to find their way out of the country, as well as Italian paintings. At the same time the division of Italy into so many rival and hostile states has had a singular effect in preventing the circulation of its literature within its own boundaries. It has often been the case, that Milan did not know what books were issued at Naples, and Florence was a comparative stranger to the current literature of Rome. The same division in Germany has been productive of exactly the opposite effects, and has led to an organisation of the book-trade superior to that which prevails in France and England. From the same cause there appears to have been no marked attempt in any Italian library to form a complete collection of Italian literature: the strong local attachment which has been sufficient to preserve in use a host of different dialects, many of them often used for literary purposes, has, at least until the present generation, prevented the mind from being sufficiently expansive to embrace all Italy from the Alps to the sea. In many of the Italian libraries also the books appear to have been kept in singular subordination to what should have been their accessories; in the Vatican library not a book is visible till presses have been opened, and the historians of its progress dwell most on its architecture, its paintings, and ornaments. The result has been that the great libraries of Paris and London are probably richer in Italian literature than any within the bounds of Italy, and that in that literature much apparently still remains to be discovered. Roscoe, the historian of Lorenzo and Leo the Tenth, expressed his surprise that after a careful study of his authorities it should still be in the power of a Bristol collector, Mr. Bright, to show him a volume of Italian popular poetry, on the battle of Pavia and other contemporary events, of which he had never seen mention, and the like of which he had no reason to suppose ever existed. There are only two copies known of a contemporary Italian popular poem of the discovery of America. They are both in the British Museum, for which both of them were bought at different times at sales in Paris. It should be added, that both the sales were of the libraries of Italian collectors.

The literature of Spain, like that of Italy, early attracted attention abroad. Spanish was for a time the language of the court of Vienna, cultivated in France and England, and well known in Italy. There is something peculiarly original and racy about many of its productions: its romances of chivalry, its ballads, its histories of wild adventure in America told by the adventurers themselves, its final comic romance of chivalry destined to throw all the others out of the saddle, its drama that followed Don Quixote, though much of it was as romantic as Amadis de Gaul. But along with the very earliest of this literature grew the weed that was destined to choke it, and the decline of Spanish letters kept pace with that of Spanish power. There is perhaps in no other European language, except possibly in that of Portugal, so great a proportion of worthless books as in that of Spain. The most ardent collector cannot but shrink from the prospect of encumbering his shelves with much of that kind of literature which flourished in Spanish convent libraries till their dissolution in 1835. Meanwhile the fate of Spain in regard to books has been signally unfortunate. Careless of bibliography themselves for a long period, the Spaniards have at length awaked to find that much of their most valuable early literature has left their shores for England, France, Germany, and the United States. In the critical editions which, much to their credit, they are now publishing of Lope de Vega, of Calderon, and others, they are often driven to confess their inability to find at Madrid copies of editions which are irrevocably fixed in the public libraries of Paris and London. A Spanish bibliographer of eminence was accustomed to say that the extravagant prices given at some English sales for a few favourite books were some of the most profitable investments that English capital ever made; for the effect had been to draw to the London market from Spain a mass of volumes which, once being there, were obliged to be sold for what prices they would bring, and brought much less at London than they would at Madrid. It was at one time much easier, he stated, to find rare Spanish books in England than in Spain, and some that now adorn the Peninsula were redeemed at low prices from English book-stalls. The Spaniards are probably not at the end of their calamities of this kind. They set us the example of planting colonies beyond the Atlantic, and there are nations which speak the Spanish language which will, in the natural course of things, begin to draw literary treasures from Spain. If their political troubles have hitherto retarded the progress of literature among these nations, the fact of their speaking Spanish has produced an interest in that language among their English-speaking neighbours which has already borne its fruits. The best recent contributions to the history of Spain and Spanish literature have come from Boston, in Massachusetts. On the whole it should be the aim of Spanish bibliographers to centralise the collections they still retain, and guard against further loss by establishing as far as possible a complete national library, in which they should also collect the Spanish publications of South America and Mexico.

Portugal stands in much the same position as Spain, except that its books have never been so much in demand abroad as those of its neighbour. By the breaking up of the libraries of the convents, the national library, established at Lisbon in 1796, has been considerably enriched; but Senhor Innocencio da Silva, the author of the excellent bibliographical dictionary of Portuguese books now publishing, remarks in almost every page that some book he is describing is not to be found in the national library. Of many of the books he has only to mention that they were in the library of Lord Stuart de Rothesay, which was sold a few years ago in London. At that sale, extensive purchases were made for the British Museum, which already possessed some of the finest and rarest works in Portuguese literature, by the accession of the King's and the Grenville libraries. The 'Cancioneiro' of Resende, the first two editions of Camoens's 'Luciad,' the early editions of Barros and Castanheda, the Hebrew Pentateuch, which was the first book printed in Portugal, are probably united in no other library, and they are here associated with a good collection of general Portuguese literature, not wanting in the recent productions of both Portugal and Brazil.

France and England have now been in close connection, whether as friends or foes—but always as rivals—for about 800 years, and the contest which has been carried on in many a field in Europe, Asia, and America, has been carried on in the field of literature also. For about the first 400 years, up to the invention of printing, the French language flourished in England, and our libraries are rich in manuscripts in that language, many of which were written by Englishmen; for part of the last 400 years the French language has often been more widely known and more extensively used in countries with which France had scarcely any connection, in Russia and Poland, than among its insular neighbours. Printing flourished in France from the moment that a German doctor of the Sorbonne invited German printers to Paris—it rose at once into elegance, and began from the first to command a foreign market. There are books in English printed for Anthony

Verard, of Paris, and some of the choicest volumes in the library of King Henry VII., of England, now in the British Museum, are volumes on vellum, printed for the same Verard. The contemporary library of the kings of France is not so rich in specimens of the Paris printer. In France, indeed, as in other countries, the books in the national language appear not to have ranked in such high estimation for "library books" as those which were in foreign languages, or were brought from abroad—were in Greek or Latin, or came from Italy. It was in France, however, in 1556 that the idea appears to have originated which has since been imitated in every country—free or despotic, monarchical or republican—of levying a "royalty" upon booksellers of one or more copies of the works they printed. Henry II., in 1556, issued an ordinance that a copy of every book issued in France should be deposited in the Royal Library. Had this order been always obeyed, and had the books thus obtained been always preserved, a great good would certainly have been effected; but in all countries, free or despotic, these orders have been often disobeyed—a fate which they probably share with all other orders, but in this case the effect of the disobedience, instead of wearing out, becomes more perceptible with the lapse of centuries. Without such a regulation, however, no very large assemblage of French literature would probably have been formed in France at all, for the great collectors of libraries in that country, in the 16th and 17th centuries, seem to have had their thoughts turned more to the acquisition of beautiful copies, on vellum or large paper, in magnificent bindings, than to the formation of complete sets of the sources of information in any branch of literature, knowledge, or history. It is related of the great collection of the President De Thou, that the owner, in some instances, supplied paper of his own to the printers of a book for a peculiar copy to be struck off, that he bought several copies of a volume to pick out from many the best impression of particular sheets, and finally that he bound his library so sumptuously that when the collection came to be dispersed the books were sold for less than the cost of the binding. With all due appreciation of "a choice Thuanus," those who do not regard a book merely as a piece of furniture, must be permitted to smile at some of these particulars. The age of Louis XIV. spread through a large portion of Europe a taste for the French language and literature, which became so exclusive and prevailed so long, that, as is well known, the library of Frederick the Great consisted entirely of volumes in the French language. This taste, however, was almost exclusively for books of the age of Louis and after it, and led to no dispersion out of France of the productions of an earlier period. Indeed, in France itself these productions were looked upon with disregard till long after a fervour had been awakened in England for Caxtons and Wynkyn de Wordes. As the Elizabethan age preceded the age of Louis XIV., and as the English Commonwealth preceded the French republic, so the age of enthusiasm for black-letter in London preceded that age of enthusiasm for black-letter which now prevails in Paris. The present period in France is equivalent to the period of the Roxburgh sale in England; and it appears to have had an analogous effect in preventing, for a time, French books from leaving France. Even when they have quitted the country they have in general only passed into the hands of Frenchmen, as, for instance, the library of M. Cigongne, which has in this year (1860) crossed the Channel to join the library of the Duke of Aumale, at Twickenham. There is still hope of recovery of these for the great library at Paris, but it has not always succeeded in obtaining the rarities of ancient French literature which have been first discovered in other parts of Europe. Until the year 1845, only five or six of the French farces of the 16th century were known to exist in different libraries in France, and the best French bibliographers, even those who gave their special attention to dramatic literature, had heard of no more. In that year a volume was discovered at Augsburg, containing sixty-four dramatic pieces of this peculiar kind, and it was sold by Mr. Asher, the German bookseller, to the British Museum. The French antiquaries could not at first believe that the volume was genuine, but all doubt has been removed by the publication of a transcript from this unique and remarkable volume at Paris.

The extent and variety of the literature of France in the 18th century drew from Dr. Johnson the emphatic commendation that they "had a book upon everything." To the intrinsic interest of that literature was added the fearful historical importance which it gained, by its having been followed by the great revolution which, in some of its phases, seemed too plainly to prove that nations may, like individuals, be subject to mental aberration. The pamphlets of that period found more than one Thomason, and extensive collections of them exist in the national libraries of both France and England. A large portion of the 'Moniteur' of those years has been since twice reprinted in its entirety, and is probably the only set of a newspaper that ever received such an honour. The history of France during the age of Napoleon, is so closely intermingled with that of England throughout, that many of the valuable historical works which have been issued upon it in France are desirable additions to any great English library, and the Museum ought to possess them all. The library at Paris, which has recently issued a catalogue, in many quarto volumes, of its collection of the history of France, appears, in this department, to be very complete, so far as French literature is concerned, but to have concerned itself but little with what has been written upon France by foreigners.

The literature of Germany is now with that of France, the richest literature of the continent. It is one of the many fortunate [illegible] The stances which attach to the English language, that it stands mi[illegible] between the two modern languages that contain the greatest amount of learning—that a person acquainted with English is by that circumstance half-acquainted with French and half with German. The history of the cultivation of the German language is striking. Singularly rich in capabilities, spoken by a great, powerful, and enlightened nation in the centre of Europe, it was for centuries neglected at home and despised abroad. It was not till about 1750 that it emerged into cultivation by native genius, and not till half a century later that it became an object of liberal study with foreigners. It is now in England the language that is most cultivated after French; it is studied in France and Italy, and is even penetrating into Spain. Always renowned for learning, its learning till about 1750 was chiefly couched in Latin, and the most ardent patriot could not imagine that its literature stood on a level with that of several foreign nations. At present, not to read German prose is to be excluded from one of the main sources of liberal information; and not to read German poetry to be shut out from the enjoyment of some of the happiest productions of genius. Professor Porson, in the early part of this century, produced a laugh by the observation that "life was not long enough to learn German"—but the laugh which is now excited by it is at Porson's expense.

Germany has always been remarkable for its numerous and extensive libraries, for the diligence, perseverance, and minute attention of its book-collectors, and for the admirable arrangements of its book-trade, in which by the agency of a book metropolis, Frankfort or Leipzig, the most active circulation has always been carried on between the heart and the extremities. It might therefore have been anticipated with some confidence, that in Germany complete collections of German literature would be found to exist. This is far from being the case. We frequently hear at the present day of collections of early German literature in private hands which contain works not in the public libraries. A few years ago the collection of Herr Von Meusebach, consisting of 36,000 German volumes, was bought in a mass for the library at Berlin—and the acquisition was spoken of as one that was absolutely necessary to place the German department in a satisfactory condition, and as giving the library at Berlin a superiority over those of Munich and Vienna. When in 1845, a large selection from the collection of Kuppitsch, a bookseller at Vienna, was bought for the British Museum, it soon turned out that some of the books thus acquired were unique, and a reprint has since been issued in Germany of one of the works of Fischart, a German humorist of the 16th century, from the Museum copy. In the catalogue of the Museum issued in 1813-19, the names of Goethe, Herder, and Lessing do not occur; and Schiller is mentioned only in connection with an English translation of the 'Ghost-seer.' The presentation of the library of George III. first brought to the Museum a creditably extensive collection of German literature and history, for which it probably was partly indebted to the taste of his German queen. That collection has since been increased at least twenty-fold. The Museum has acquired more than thirty-thousand German volumes in the course of the last ten years. Much as the literature of Germany is cultivated in Russia and the north, and large as are the libraries of Petersburg and Copenhagen, the German library of the British Museum is now probably the finest out of Germany.

With German the series of languages closes, of which specimens may be expected to be found in the shops of foreign booksellers in London or in the foreign circulating libraries of the metropolis. The other modern languages of Europe do not make their appearance in England in ordinary literary commerce, and are not taught as a branch of education. With Dutch or Danish, or Swedish, it can hardly be expected that it will ever be otherwise; but Russia with its sixty-five millions of speakers, and the growing importance of its empire, may probably in the next generation play the same part that German has done in this. In the meantime the arguments that have been used with respect to augmentations of the national library, may be applied with increased force to the measure of providing it with the best literature of these languages. One of the great purposes of a national library is to assist the student. The nation does not merely provide books for the amusement or edification of the many, but also for the instruction of the studious few, that through the medium of those few the great body of the public may receive a benefit not otherwise attainable. A score of men who read Dutch or Danish, may, by having access to ample stores of Dutch and Danish literature, be enabled to keep an eye on all that has interest or importance for the English public, and bring it effectually forward.

Dutch is a language that has stores of much interest, both in old and recent times,—in the relations of its early voyagers, and in the large body of information on record concerning its empire in the East. There are also long sets of tracts or pamphlets of the 17th century, bearing on the commerce of the East and West Indies, and on the striking political events of that century in which Holland so gracefully terminated its long struggle with England by sending us the vindicator of English liberty. The Dutch have many libraries, but none of remarkable extent, and they have bestowed little attention on the collection and preservation of their own literature. The largest assemblage of the Dutch drama in existence has somehow found its way to the

Partial library at Paris, which in other respects is not rich in the literature of Holland. The largest collection of Dutch books anywhere assembled is in the library of the "Society of Dutch Literature" at Leyden, of which a valuable catalogue has been published. There is good reason to suppose that the British Museum contains the largest collection to be met with anywhere out of Holland, and that it does not yield to any library in Holland in this respect, except that of Leyden. The same language, called Dutch in one country and Flemish in the other, is, with small variations of dialect, common to Holland and Belgium, but neglect of the national language in Belgium, and the aversion which has often prevailed between the two countries, has prevented either from paying sufficient attention to the literature of the other, while at the Museum neither has of late years been neglected.

The ancient language of the North, which still flourishes in Iceland, and was by common consent till lately denominated Icelandic, produced in the middle ages a body of literature, much of which has, since the invention of printing, been given to the press in Iceland, in Denmark, and lately in Norway, while much more still remains in manuscript. The recently founded library of Reikiavik, the capital of Iceland, contains less of this printed literature than may be found in the British Museum, which had the advantage of receiving from Sir Joseph Banks a collection made during his visit to Iceland, and comprising some of the rarest volumes, acquired from the library of Halfdan Einarsson, the historian of Icelandic literature. To this have been added a collection offered to the Museum by the learned Icelander, Finn Magnusson, and of late years everything of interest that has appeared in this very curious branch of letters. The older literature of Denmark has never yet been much sought after beyond the boundaries where the language is spoken. In its own country the collection made by Hjelmsterne, and presented to the royal library of Copenhagen in 1807, made the first approach to completeness. The Danish department in that library was then made a separate one, and the object of particular care; and about that time it might have been expected with some confidence that it would be the most complete collection of a national literature made by any nation in Europe. Danish was then spoken by no one beyond the dominions of the King of Denmark; his authority, though paternal, was despotic, and the law to deliver a copy of every book in his dominions to the royal library was so peremptory, that at first five copies were required. The prospect soon vanished. Norway was separated from Denmark in 1814, and took almost immediately to perplexing Europe by calling the language it speaks Norwegian, though the same idiom prevails at Copenhagen and Christiania, with some slight difference of pronunciation, which a patriotic Norwegian sedulously exaggerates. Of course the library of Copenhagen lost its claim to Norwegian books, and can, like other libraries, only receive them by present or acquire them by purchase. At the same time the Norwegian literature, since the separation of the countries, has become of more importance, though still of such small extent that it has been asserted that the expenditure of a few pounds a-year would procure a copy of everything issued in Norway. The British Museum received with the library of George III. a valuable collection of Danish books, which has of late years been carefully increased; and it probably at present surpasses every library out of Scandinavia in its stores of the literature of Denmark and Norway.

Sweden, like Denmark, has had no foreign competitor for its earlier literary treasures. In Schroeder's work on the earliest productions of the Swedish press, the books he enumerates are extant in a very small number of copies, and those copies are almost all described as existing in Sweden. In that country, as formerly in England, the principal library is not in the capital, but in the chief university—that of Upsal; and this collection, which far surpasses that of Stockholm, but is itself inferior not only to the royal library of Copenhagen but to the university library of that city, contains a large number of Swedish books; but has, like other university libraries, never been directed with a view to embracing a complete collection of the national literature. Sweden too, like Denmark, has suffered in this century a dismemberment. The conquest of Finland by Russia took from it a country in which, though the language of the uneducated classes was Finnish, the language of the educated was Swedish. Runeberg, the most popular poet now living in the Swedish language, is by birth and residence a Finlander, and has never been in Sweden. Few Swedish libraries are extant out of Scandinavia, except in parts of Germany and Russia which were formerly Swedish provinces, and none of these are probably so extensive as that now in the British Museum.

The literature of Hungary is almost entirely a growth of the latter part of the 18th century, and of the 19th. The language, a branch of the Tartar stock, was revived, when sinking into decay, by the exertions of Kazinczy, and by the attempt of the emperor Joseph to suppress it. It has now become the object of enthusiastic affection on the part of those who speak it, and who were congratulated on their possessing such a noble organ of thought and poetry by the great linguist Mezzofanti. The number of works published in the language in 1795 was 22, and in 1855 no less than 640. The fine library of Count Francis Szechenyi, which was given in 1802 as the foundation of a national museum at Pesth, has since grown to a collection which was stated in 1859 to contain 180,000 volumes, of which 36,000 were Hungarian books, and 20,000 of the remainder were books relating to Hungary. These numbers are no doubt much exaggerated, but the catalogue of the original collection which was printed at Szechenyi's expense before the donation was made shows that he had amassed with uncommon care and success almost everything that related to the history, the topography, and the literature of the country. If the collection has been continued on the same scale, as it probably has been, it must present as complete a specimen of what a national library should be as exists in Europe. In the British Museum there is a fine collection of books on Hungarian topography and history, and also of books in the Hungarian language, which may be called an abridgment of the Szechenyi Museum. The Hungarian refugees who arrived in London after the failure of the revolution of 1848, must have been agreeably surprised to find arrived before them all their best authors and most distinguished periodical publications, in an abundance which showed that the frequent complaint of Hungarian patriots was not in this instance justified—that Hungary had not been overlooked or forgotten.

The success of other languages has led the Wallachians recently to attempt a national literature, which was commenced within the last twenty years by the translation of some popular French novels into Wallachian or "Roumanic," by a native princess. This not very promising beginning has been followed up by a host of other translations, and by a few original efforts, some of which appear to have merit. The political importance which has been lately attained by Wallachia and Moldavia has given rise to a flood of pamphlets and political writings; and the peculiar position of the Wallachian as a solitary Romanic language in the east of Europe, has lent it an interest that otherwise would scarcely belong to it. Most of the original publications in Wallachian are in the British Museum.

The Servian language has far other claims to notice in its beautiful and spirited ballads, which have attracted from their first appearance the admiration of all literary Europe. The Servian literature is collected with care in the libraries of other Slavonic countries, but there appears to be no public library at Belgrade.

The ancient connection of Bohemia with England by the marriage of Richard II. to a Bohemian queen, led to the introduction of the doctrines of Wickliffe from the university of Oxford to the university of Prague, and so to the cultivation of the national language in the struggle which ensued with the Catholic clergy. Bohemia was the first of the Slavonic languages which had a printed literature; but, after the defeat of Bohemian Protestantism in the Thirty Years' War, that literature was also attempted to be suppressed. A Jesuit father of the 17th century, is branded with infamy as having for many years collected Bohemian books for the purpose of destroying them, an attempt in which he had no common share of success. As in the case of Hungary, the Bohemian language was sinking into apparently irrecoverable decay, and yielding the ground it had formerly occupied to German, when this tendency was arrested by the exertions of native scholars, and for some years past the language has been growing more and more into literary cultivation. One of the chief measures taken by the national party was the establishment of a "Bohemian Museum" at Prague, to contain among other things a collection of Bohemian literature. Bohemian is not like Hungarian, an isolated language; and the recent Panslavistic movement has called attention to Bohemia and its literature in other Slavonic countries. The library of St. Petersburg was enriched in 1852 by the purchase of the library of Jungmann, the author of the great Bohemian dictionary, and the historian of Bohemian literature. The student of the language will find a good collection of Bohemian books of recent date, and some curious ones of an older date, in the British Museum.

The literature of Poland has been remarkably unfortunate. It had a period of cultivation almost contemporary with our Elizabethan age, but its early productions rival in scarcity those of Bohemia, for though they were not made the object of systematic persecution, the indifference of the Poles to literary treasures has been so marked, that most of their ancient books have been gradually consigned to destruction by mere carelessness and wantonness. When Zaluski in the 18th century, brought together his immense library, one of his principal objects was to amass everything that related to Poland, and it is stated that 20,000 of his volumes had reference to this subject, though the whole number of books in the Polish language in his library was less than 5000. Many of the books in this collection were unique, and of form a second collection approaching to it in completeness was out of the question. When, therefore, the whole Zaluski library was carried off, as has been already stated, to St. Petersburgh by the Russians, the Poles sustained not only a great but an irreparable loss. On the second occasion of the seizure of the Polish libraries in 1833, the Emperor Nicolas was, it appears, considerate enough to direct that books in Polish and books on medical subjects should be permitted to remain in Warsaw. The Polish emigrants have since established a Polish library in Paris, and Prince Adam Czartoryski, the same from whom the Russians took the library of Pulawy, presented to the British Museum in 1833, a small collection of seventy or eighty Polish volumes. A few years afterwards, the movement commenced for increasing the Museum library, and it has now the richest collection of Polish literature out of Poland and Russia. To judge from the occasional complaints of Warsaw journals as to the defective literary communication between that capital and Posen and Cracow, it is not improbable that Polish books from the three literary centres of the Polish language under three different governments, may be often assembled in London before they meet on their native soil. On that native soil many of the literary productions of the Polish 'emigration' are of course forbidden to appear at all, while at the Museum they are still but imperfectly represented, though care is now taken to collect them from the different localities where they appear, at Leipzig, or Poitiers, or Tottenham. Amid the convulsions of the continent, and the dangers and circumscriptions which surround Polish libraries in Poland, it is far from improbable that the future historian of Polish literature may have to seek some of his best materials in Great Russell Street.

The literature of Russia commenced in the year 1708. It was then that Peter the Great issued his new alphabet, an improvement on the old and clumsy Slavonic alphabet which it supplanted, but still retaining one of its worst defects, in a silent letter, which in every Russian volume wastefully consumes at least a sheet. Along with the alphabet the old Slavonic language was abandoned, and the Russian, which had hitherto been spoken, not written, became the language of literature. A collection of it was located in a very singular quarter. Denis, the author of the 'Introduction to Bibliography,' tells us in 1775, and again in 1796, in his account of all the libraries of Italy, that in that of Modena was a collection of all the Russian books ever printed, and the statement is repeated in 1846, in Roncetti's Italian translation of Denis, a carefully edited book, with excellent illustrative notes. Meanwhile, with regard to the great Zaluski library of Warsaw, collected by a Pole, and rich in Slavonic literature, there is a disagreement among authorities as to the number of Russian books it contained, some stating that there were five, and others that there were only four. When the library was removed to St. Petersburg, and made the public library of Russia, measures were taken to remedy this defect, and in the official guide to that library, published in 1850, the number of Russian books, forming a separate department with a separate librarian, is stated at 40,000, and it has since been materially augmented. The literature of Russia is now in a period of gigantic growth, and some of its productions are individually of gigantic size. A single number of a Russian monthly or fortnightly magazine, is generally of the dimensions of an English quarterly review, and a periodical of the first class, of which there are several, presents its readers in the course of a twelvemonth with six or seven thousand closely printed octavo pages, in which are inserted as articles among the original matter, complete translations of such works as Prescott's 'Conquest of Mexico,' or Kingsley's 'Two Years Ago.'

It is one of the most singular literary phenomena of our time that this great movement is taking place among a nation of nearly seventy millions of population, and that it is in most other countries so thoroughly *ignored*. The Russian authors abound in talent, and some of them have manifested genius; their subjects are full of interest. If they treat of their own topography, it is that of so mighty a portion of the earth's surface, that it cannot fail to have a general bearing; if of their own history, it is so intimately connected in modern times with that of Europe in general, and England in particular, that a more intimate acquaintance with it is highly desirable. They are great travellers also, and there is much in their observations on our own and other countries that deserves attention. Their admiration of English literature is warm, but not indiscriminate; and while in Spain or Italy we might seek in vain for critics who appreciate our merits or detect our faults, the observations of Russians may perhaps anticipate the judgment of posterity. In matters of politics, their freedom of speech is greater than we suppose, and they write much on subjects of contemporary history. Of late years, a 'Russian Free Press' has been established in London, in which some of their most eloquent writers express their opinions altogether without restraint, and as these publications are known to be constantly read by the emperor, they exercise an important political influence in Russia itself. Beyond the limits of Russia there is now apparently no Russian library of great extent—that of Modena being anterior to the great movement in Russian literature—except the collection in the British Museum. Four or five-and-twenty years ago, a solitary English student who had set himself to master the Russian language, found himself thrown entirely on his own resources for prosecuting the study of its literature. It was the same, not only with Russian, but with Polish, with Bohemian, with Servian, with Hungarian, with Dutch, with Danish, with Swedish—in short, with all the secondary languages of Europe. No large collection of any one of them then existed in England, unless possibly in private hands. No large public collection of any of them is known now to exist in England except under one roof, that of the British Museum, and there they are all assembled. Small as has been the cost of amassing it—less probably for the whole, than was given at Paris a few years ago for a single one of Marshal Soult's 'Murillos'—it is a collection unrivalled of its kind in Europe. The poorest student who has access to the British Museum has now access to unlimited stores, of which he has only to bring the key.

The literature of Russia is one of the most recent, the literature of its bordering empire, China, is the most ancient, to which the art of printing has been applied. I is no less strange than true, that that admirable art was first invented in the country of all the world to whose language its benefits are least applicable—in a country destitute of an alphabet—and that while exercised there for centuries, it never penetrated into the neighbouring states of India, a land of literature and civilisation, with the most perfect alphabet in existence. The date of its first discovery is stated by M. Stanislas Julien, the eminent Chinese scholar, to be assigned by Chinese authorities to the 6th century of the Christian era, more than eight hundred years prior to the discovery of Gutenberg. Through all the vicissitudes from the time of "the burning of the books" by the first emperor of united China, to the war against learning carried on by the present insurgents, literature has flourished in the "middle kingdom," in which it has in part taken the place of religion. The literature of China has always been more akin to that of modern Europe than that of any other Asiatic country. The Chinese have plays, which are a kind of composition unknown to the Arabs and Persians; they have novels and newspapers; they publish criminal trials; they circulate gratuitously religious and temperance tracts of their own. In regard to libraries their state is somewhat problematical. M. Abel Rémusat, in many respects a most judicious and critical writer, tells us in one of his Essays, that an Emperor of China ordered the publication of a select collection of the Chinese classics in 186,000 volumes.

A native Chinese, who was asked in the present year (1860), at the British Museum, what was the largest library in China, said that he had never been to Peking, but that at Hang-chew he had seen one of 6,000,000 volumes; an excellent library to receive the gigantic edition of the Chinese classics. Nothing can be more different from these extraordinary statements, than those of other Chinese scholars and travellers. There is in the British Museum, as in other European libraries, a catalogue printed in China in 1790, of the library of the Emperor Kéen Lung, the same who received Lord Macartney. M. Bazin, who published an analysis of this catalogue in the Paris 'Journal Asiatique' for 1850, states that he found it only contained 10,500 distinct works, including, it may be observed, 303 of the nature of encyclopædias, some of which were of large extent. The library did not contain any work in the common and familiar language of China, and all plays, novels, and works of light literature were thus excluded. Rémusat himself, in a subsequent work to that in which he mentioned the edition of the classics, fixed the number of volumes in the largest Chinese library at 300,000, and his first statement respecting the classics is so obviously the fruit of some confusion between "volumes" and "books" or "chapters," that it is surprising other Chinese scholars should have repeated it without suspicion. It is evident that large libraries are rare in China. Europeans who have spent nearly twenty years in the country, and seen more than one of its large cities, report that they never happened to see an extensive collection of books. Collections of ancient porcelain vases are numerous in China, but not collections of ancient volumes. Dr. Schott, in his Survey of Chinese Literature, in the Transactions of the Berlin Academy, quotes the existence of a Chinese printed book at St. Petersburg with the date 1419, as a phenomenon, and observes that it shows the opinion to be erroneous, that a Chinese book can hardly last longer than three centuries on account of the thickness of the paper. The white ants are also great enemies of Chinese literature. In fact, in the libraries of Chinese temples, founded by the Emperor Kang He, who reigned from 1661 to 1722, it is reported by European observers, that many of the books are now illegible from decay, and it is far from improbable that some of the Chinese books presented to the Bodleian, by Archbishop Laud, soon after its foundation in 1602, may be of older date than any to be readily met with in China itself.

Chinese libraries are more numerous in Europe than Russian libraries. There is a fine one at Paris, containing many volumes presented to Louis XIV. by the then reigning Emperor of China; there is one at St. Petersburg, one at Berlin, one at Vienna, and several in London. There is a collection at the East India House, Sir George Staunton's collection in the library of the Royal Asiatic Society, Dr. Morrison the lexicographer's collection at University College, and Dr. Morrison the younger's collection united to Mr. Hull's and several others, at the British Museum. The Museum collection, to which the presentation of Dr. Morrison the younger's library by the British government, added 11,500 volumes at once, is probably of not less than 20,000 volumes, and is scarcely inferior in numbers to any other in Europe.

The nations which are under the influence of Chinese civilisation are all cultivators of printing. The literature of the Manchoo-Tartars, who are intellectually subject to China, though they hold the position of its conquerors, is devoid of interest, as consisting almost entirely of servile translations from Chinese. The Japanese books are not translations from the Chinese, but in most cases Chinese books with Japanese notes and explanations, mixed up in such a state of confusion that the accounts which recent travellers give us of the superiority of the Japanese to the Chinese in point of sagacity and ingenuity, appear to require confirmation before they can be admitted in matters of literature. Siebold, who enjoyed unusual opportunities of observation, stated that libraries are numerous in Japan, and that those both of the secular and the ecclesiastical empire were extensive, but declined giving any opinion as to the numbers which Balbi assumed to be about 150,000 volumes in each. If Siebold's statement were well-founded, that "from five to eight thousand" small volumes, maps, &c. were annually published in the Japanese cities, this estimate has nothing improbable.

Of Manchoo-Tartar books the largest collections in Europe are at

Paris, that language having been a peculiar favourite of the French missionaries; and there is a small collection in the British Museum. The largest assemblage of Japanese books at present in Europe is that at Leyden, brought by Siebold from Japàn; but there are others at Vienna and Paris, and a few volumes, probably soon to be augmented, in our own national library.

After leaving China and Japan, it is necessary, in order to find another Asiatic nation, the main body of whose literature exists in print, to pass to the western extremity of Asia, and for the chief seat of its printing-presses to look still further westward in Europe. It is from the island-convent of St. Lazzaro, near Venice, that the chief supply of books is sent forth to the Armenians, the "Jews of Christendom." The same order of literary monks as flourishes at Venice, the Mechitarists, have now founded branch establishments in Vienna and Paris, at which the press is in full activity. They issue not only editions of the ancient Armenian historians, Moses of Chorene and others, but translations of the most popular and useful works from the European languages—Rollin's 'History' and Büsching's 'Geography,' the 'Paradise Lost' and the 'Night Thoughts,' 'Robinson Crusoe' and 'Uncle Tom's Cabin.' In some antagonism to the Roman Catholic Armenians of Venice, who are attached to ancient Armenian, the American missionaries at Smyrna and elsewhere support Protestantism in modern Armenian; and a few books in the language find their way from the press at Calcutta. Of the Venetian publications, there are probably sets in many European libraries, and the Museum has one which is believed to be complete in all but translations, and includes a large selection of these.

The literature of Sanscrit, the ancient language of India, was first made known beyond its ancestral precincts by the researches of Englishmen. The names of Wilkins, Colebrooke, and Wilson, will always receive the veneration of scholars for their inestimable labours as pioneers in a field of study so ancient in one sense, so novel in another. Scarcely half a century has elapsed since the publication of Wilkins's Grammar, and the discovery of the Sanscrit language has changed the basis of philology. A language which eighty years ago was not known to a single European, now counts its professors and students at Oxford and Berlin. Active however as the press has been, both in India and Europe, to reproduce some of the chief productions of Sanscrit literature, the main body of that literature must still be sought not in libraries of printed books, but of manuscripts. There are now collections of some value at Berlin and Oxford, and even at Copenhagen and Paris, but the collection bequeathed by Colebrooke to the East India House at London, is the finest in Europe, and has been a magnet of attraction to Sanscrit scholars, similar to that presented to Hebrew scholars by the Oppenheimer collection at the Bodleian. The Sanscrit manuscripts at the Museum are less than 130, at the East India House more, it is believed, than 3000 volumes, and each volume there, on an average, contains four or five tracts. The best continental scholars are of opinion that without access to that collection, the study of Sanscrit literature cannot be satisfactorily pursued. The recent abolition of the East India Company has made the fate of their library a question for decision, and it is probable that most scholars would wish to see it deposited in the British Museum, were it not that the regulations of the Museum prevent the manuscripts from being taken from within its walls, while the regulations of the East India library are in that respect more liberal than those of any other English establishment.

The languages of India, after the Sanscrit, more than twenty in number, have, except the Hindustanee, little of literary interest, as in most cases they contain hardly anything but translations, whether of works from other oriental languages by natives, or of the Bible by missionaries, or of medical and scientific works by other Europeans, anxious to improve the native mind. Slender as the individual importance of these productions may be, it is still wonderful that so little attempt appears to have been made to collect them, either in India or England; for in the first place they are certain to have some kind of philological value, and in the second they are memorials of one of the most singular phases of society that has ever existed. The English student of one of the languages, with a view of qualifying himself for office in India, might be materially benefited by finding assembled here a good collection of its literature. The best of the kind in London are at the Royal Asiatic Society and at the East India House; but much still remains to be done.

The languages of the Eastern Archipelago, the Javanese, the Bugis, and others, and the omnipresent Malay, present points of interest; and since the time when Sir Stamford Raffles as governor of Java made such vigorous inroads into the realm of ignorance, the Dutch have awakened to wipe away that reproach which was formerly made to them of neglecting studies to which they alone had easy access. Within the last twenty years the Dutch scholars have cultivated the languages of the Archipelago with equal zeal and success, and deserve for their exertions in this matter, the thanks of literary Europe. Of course it is in the Dutch libraries that manuscripts of them are to be found in the greatest abundance; but in the British Museum there is an admirable collection, made by Mr. Crawford, amounting to about 150, and there are also the collections of Marsden at King's College, and of Leyden at the East India House.

All the Mohammedan world, however, in India, in the Eastern Archipelago and elsewhere, looks for its treasures of literature to one of what are emphatically called "the three languages"—the three great idioms of Western Asia and of Northern Africa—the Arabic, Persian, and Turkish. The literature of the Arabic—of the language which was once not only that of Mecca and Cairo and Fez, but of Cordova and Granada, is now fallen from its high estate. The Mohammedans are paying the penalty of that obstinate aversion to printing, which might almost be considered a part of their religion. The process as practised in China, was described by a Persian historian, who was contemporary with the Crusades; but the description of printing by Rashid-ed-din, remained itself in manuscript till printed at Paris in the 19th century. The art was introduced into Spain more than twenty years before Boabdil was driven forth from Granada; but the first book printed in that city was two years after his expulsion. For centuries after, in Mohammedan countries, the art was contemptuously left to Jews and Christians. The increasing preponderance of the Franks has at last brought about some change, and Arabic books are now printed at Constantinople, at Boulak, near Cairo, at Algiers, and in India. While the French at Algiers print much of the old Arabic literature, the Mohammedans at Boulak chiefly issue translations from the French, of treatises on tactics, mathematics, and medicine. Of Arabic libraries the chief are in Cairo; but there and elsewhere the Arabic libraries of the present day represent the literature of classic Arabic, as the monastic libraries of the middle ages represented the classic literature of Greece and Rome. The Arabic historian, Ibn Aby Tay, affirms, as M. Quatremère tells us, that in the old library of Cairo there were 1200 copies of the history of El-Tabari, a statement that reminds the modern English reader of the 2000 or 3000 copies of Macaulay's History, and M'Clintock's Voyage, in Mudie's circulating library. Every copy of the Arabic of El-Tabari had disappeared and the book was only known in its Persian translation, till a portion of the Arabic was recently discovered in Europe. A similar history will have to be told of many an Arabic classic, which now probably only exists in the great libraries of the Franks. At Paris, at Leyden, at Oxford, at St. Petersburg, and at Vienna, there are large collections, and that at the British Museum is of considerable importance. Sims's useful 'Handbook to the Museum' gives the number of manuscripts as 1060.

While Arabic is to the Mohammedan what Latin is to the Catholic nations, the more easy and familiar Persian takes rather the place of French, and was long to India what the French was to Germany. In the library of Tippoo Sahib, which was chiefly composed of that taken by his father Hyder Ali by force of arms from the Nabob of Cheetore, it was found upon its transference to the East India House, after the fall of Seringapatam that the number of Arabic and Persian works was nearly 2000, and a few works in Hindustanee and other languages completed the library. Stewart, who published the catalogue, expressed his surprise at the number of the volumes; but the library of the king of Oude, which was catalogued by Dr. Sprenger in 1848 at Lucknow, was far superior in numbers though inferior in condition, being devoured by rats and white ants. At Lucknow, the invention of Senefelder had found more favour in Oriental eyes than the invention of Gutenberg. Twelve lithographic presses were at work in the town before some arbitrary caprice of the king of Oude put a check on their activity. More Persian books have been printed and lithographed in India than in Persia itself, where a printing press has however been established in Teheran, which issues a newspaper. Of the three editions of the greatest of Persian poets, Ferdusi, two were printed at Calcutta by Englishmen, and the other at Paris by a German; but most of the treasures of Persian literature are still to be sought in manuscript. Fine libraries of Persian are to be found at Paris, at St. Petersburg (where the collection of oriental manuscripts in the library of the Academy is supposed to be the finest in Europe out of Paris), and at Leyden, Oxford, and London. Tippoo Sahib's library is now in the East India House, and the number of Persian manuscripts at the Museum is given as 1082.

The Turkish language, though far from being of such general literary importance as Arabic and Persian, is abundant in poets, and rich in historians, whose narratives are more generally interesting as describing the Turkish collisions with the more civilised nations whom they unhappily conquered. Its relative importance is well represented by its numbers in the British Museum, in which it counts less than three hundred manuscripts, while Arabic and Persian are, as we have seen, each over a thousand. Printing was partially established in Constantinople at the commencement of the 18th century, and after a long interval of interruption, again in the 19th. The libraries at Constantinople appear to represent the extreme of decentralisation. There are no less than forty of them, and the number of books in each varies according to Von Hammer, from 2000 to 2500, so that the aggregate number of volumes is about 100,000, of which of course the greater part are not only duplicates but triplicates and endless repetitions. Zenker in his 'Bibliotheca Orientalis,' published at Leipzig in 1846, aims at giving a catalogue of all the books in the Arabic, Persian, and Turkish languages, printed either in Europe or Asia, and, even including translations, the number of which he has succeeded in collecting notices is only 1859.

In our literary journey round the world we have been compelled to pass almost insensibly from printed books to manuscripts. Those who would make a general survey of the published literature of the living world four centuries after the invention of printing, must still extend their view beyond the circle of printed books. This state of things furnishes an additional reason for the arrangement which has been so generally adopted in libraries, of either keeping the manuscript and printed books together if the collection is small, or merely dividing them if the collection is large, into two separate departments kept in the same building.

Some of the most ancient contents of manuscript libraries are among the most recently discovered. The 19th century has already distinguished itself beyond all preceding centuries by its success in making the boundaries of the past recede. While geologists claim to delve into the early history of the earth, the archæologists of art have unearthed the sculptures and paintings of Egypt and Assyria, and the archæologists of literature have decyphered Egyptian hieroglyphics and arrow-headed inscriptions. Amid the treasures of the British Museum are 206 hieroglyphical manuscripts on Egyptian papyrus, and what has been called the "library of clay" of the kings of Assyria, disinterred from under pyramids and from buried palaces. In the saloons of Great Russell Street there is now lodged a mass of inscribed earthen cylinders in the arrow-headed character, from which Rawlinson and Norris hope to decipher chronicles and leases, religious books, and grammars. Less ancient indeed than these, but still of very remote antiquity, are the Syrian manuscripts, acquired between 1841 and 1847, from the monasteries of the desert of Nitria, about 1000 in number, and ranging in date from A.D. 411 to A.D. 1292.

The ancient manuscripts of the languages of Greece and Rome in their classical periods have been the ornament of libraries from the time of the revival of literature to the present. They have served their most important purpose by aiding scholars to form a standard text of classical authors whose works, once only existing in perhaps two or three copies, have now passed through innumerable editions, and are found wherever literature is known. It has been remarked that the purity and intelligibility of an author's text are generally in exact proportion to the number of ancient copies of his writings that have been discovered and collated. The manuscripts themselves remained after this use had been made of them, interesting monuments of the past, still more venerable than the earliest editions of printed authors, but regarded as having in a measure "done their work" until the reading of palimpsests by Niebuhr and Mai, in the earlier part of the 19th century, threw a new interest over the contents of old libraries, which it was now seen, might like mineral districts contain treasures beneath superior to those on the surface. A fragment of the Roman historian Licinianus has thus been recovered by the two Drs. Pertz, father and son, from a manuscript in the British Museum. Almost all Greek classical manuscripts now in existence are in public libraries, where they are open to collation, and free to be used for the purposes of learning; but there are still a few in situations, such as the conventual libraries of Mount Athos, where they are not easily accessible to the world of editors, and where their possessors are not qualified to use them to advantage. It has been proposed to apply to them the new process of photography for the purpose of reproducing exact facsimiles for the principal libraries of Europe; where they might then be used for the collation of texts with as much confidence as if the originals had been transferred there. A Russian photographer contributed to the exhibition of the Photographic Society in London, some admirable specimens of a reproduction of several pages of a "codex" of Strabo at Mount Athos. The introduction of the new art is probably destined to work a revolution in collections of ancient manuscripts, but it is not yet satisfactorily ascertained that copies can be allowed to be taken without risk of injury to the original. When this obstacle is got over, as there is reason to hope that in a few years it will be, every library of the first rank will probably aim at having facsimiles of the leading manuscripts of the world.

Manuscripts of the middle ages—considering the middle ages to terminate with the invention of printing—are still existing in large numbers unprinted, not only in public libraries, but in private hands. It is probable that a hundred years hence the students of European literature will have much better means at command than ourselves, to take a comprehensive view of the literature of Europe during the earlier part of this "Yearthousand,"—to use a Germanism which is in many respects preferable to "Millennium." The proper use of the treasures of manuscript libraries seems at last likely to be made—by leaving them in manuscript no longer. The French are for the first time publishing their early epics, their long neglected 'Chansons de Geste,' their collections of national songs, their monuments of early language. The Spaniards have printed their 'Cancionero de Baena,' from a manuscript which they were obliged to borrow from Paris, where it is now in possession of the Imperial Library, which had acquired it at a sale in London. In England we are much in arrear. A few years ago it was announced that a society had for the first time taken it in hand to publish a complete edition of the works of King Alfred, on occasion of the thousandth anniversary of his birth, and the undertaking has not been carried out. Under the auspices of the Master of the Rolls, a number of our early historians are now, for the first time, being given to the public. The numerous publishing societies, with the Roxburghe Club, and its more liberal and large-hearted imitators, the Scottish Clubs at their head, have done much in the same good cause. The British Museum has been the principal mine in which these labourers have worked, and the same collection has also been explored by missionaries of literature sent by the governments of France and Belgium. These have declared that the Museum contained wealth they had not expected in ancient French manuscript literature, while Dr. Pertz, of Berlin, has gone so far as to give his opinion that "if things continue in their present course, every manuscript in Europe, that is not locked up in fiscal collections, or does not become so, will, in the course of another century, become the property of the British Museum." It is not easy, however, to be confident of the accuracy of a prediction so desirable to be accomplished, for in England itself there have been forming in the present generation, two collections of manuscripts in private hands—those of Lord Ashburnham and Sir Thomas Phillipps, of Middlehill—each of which has absorbed more than that of the Museum in the same period of time.

One of the most interesting portions of manuscript collections consists in the illustrated works of the times anterior to printing—the illuminated manuscripts. The illuminations are often the most valuable memorials of the costume and the domestic manners of the period in which they were executed, apart from their merit as works of art, which are sometimes of no mean order. A collection of works of this kind, which have belonged to distinguished personages—for the more valuable specimens almost always bear traces of the parties for whom they were executed, or to whom they successively belonged—presents a union of interest singularly attractive. The Museum is very rich in treasures of this kind. An account of some of the most conspicuous may be found in Waagen's 'Art and Artists in England.'

The state papers and documents of modern times form some of the most interesting portions of those manuscript collections the materials of which are contemporaneous with printing. It has always been the aim of governments to shroud at least some of these documents in secrecy for a time, but their wish has often been remarkably baffled. The most valuable portion of the Cottonian library consisted of documents of historical importance so near to the collector's own period that it is no wonder the government looked on them with jealousy. King James I. found in private hands some of the most deeply interesting papers relating to the captivity and execution of his mother, and his own conduct on the occasion. There seems no adequate reason why, as these Cottonian state papers have now been for more than a hundred years in the British Museum, and nothing but good has resulted from it, the whole of the documents of the State Paper Office, of that and anterior dates, should not, as has often been suggested, be made equally accessible, either by transferring them thither or by adopting at the office the same regulations as at the Museum. Even those of later dates, down at least as far as the revolution of 1688, might, apparently with advantage, be considered to have passed from the domain of statesmanship to that of history. The 'Calendars 'of these State Papers, which are now being issued from the press, will, in all probability, place the advisability of this measure in a stronger light, by showing of how many transactions a portion of the evidence is to be found at the Museum and a portion at the State Paper Office. These 'Calendars' were in some measure anticipated by similar lists published in America, of documents relating to the history of some of the states when colonies of Great Britain, which were made by Americans—Henry Stevens and others—at the office, by permission of the Secretary of State. A similar liberality has been exercised by foreign governments towards our own, in allowing copies of documents in foreign libraries, which are illustrative of English history, to be taken and deposited in the British Museum. Such are a collection of fifty volumes of papers from the Vatican, and a number of others from the Hague, which were much used by Macaulay in his 'History of England.' It has been suggested that the more ancient portion of the English legal records, which are to be assembled at the Record Office now building in Fetter Lane, and the ancient wills at Doctors' Commons, no longer of probable use for any but literary purposes, should be deposited at the British Museum, whence they can easily be reclaimed if any unexpected occasion for their legal use should arise. The extent of these, however, is so great, and their general interest so little, that the question does not stand upon the same footing with that regarding the State Papers. It may still be advisable to make a difference between libraries and archives. The collection of the archives of Venice, which was formed by the Emperor Francis I., of Austria, is said by Balbi, to be composed of 1890 different collections, to occupy 298 chambers, saloons, and corridors, and to extend to 8,664,709 volumes, the matter of which would occupy about three millions and a half of ordinary octavos. Our own records, though not so voluminous as these, are still said to be some of the completest in Europe. Such vast collections of matter may well demand an edifice and a staff of officers for themselves.

Even in times when printing becomes more general in its use than it is now, or has ever been, there will still be an occasion for forming libraries of some contemporary manuscripts. Collections of autographs will always be eagerly sought after: the original manuscripts of the compositions of great authors will always command a deep and respectful interest. "Breathes there the man with soul so dead" who can look with indifference on the original manuscript of Walter Scott's 'Kenilworth,' or Burns's sketch of his own life, or the deed by which

Milton sold 'Paradise Lost,' or the autograph of Shakspere, or the will of Mary Queen of Scots, or the lines that Lady Jane Grey wrote in the prayer-book she had with her on the scaffold? All these are in the Museum; but it has no large collection of recent autographs, such as is now possessed by several continental libraries, and would be of frequent use for the verification of the authenticity of signatures. The diaries of Byron, of Walter Scott, and of Moore—books such as these should also be secured, if possible, for our national library, for, by their remaining in private hands, an occasion is lost for much innocent and ennobling gratification of the public. A library of printed books resembles a collection of engravings, a library of manuscripts resembles a collection of paintings; and as the one cannot aspire to the completeness of the other, it should aim at making up for the deficiency by the high excellence of some of its constituents. Such books as have been mentioned would be equivalent to a fine Raffaelle or Murillo.

A great library of printed books and manuscripts will thus, if carried out on a scale worthy of a great nation, comprise specimens of every kind of literature that the world has produced, from the earliest that the tooth of time has spared to the last and least in date—from the library of the kings of Assyria to the 'Clerkenwell News.' A national collection of this kind is the greatest of ornaments to a capital, and yet is of still greater use than ornament. It is a boon to the casual visitor, still more to the constant resident, for its treasures are inexhaustible in the limits of a hundred lives.

The rules which are applicable to the collection and management of a large public library are certainly the same in principle which are applicable to those of a small one. The difference is only in the scale on which they are to be applied; but the effect of this difference is in some things enormous. In the case of a large library, not only must everything be done more extensively, but many things more minutely. Errors and oversights which are of small consequence in a small catalogue, for instance, are not only more difficult to avoid in a large one, but when they are not avoided they are more misleading and more confusing.

It has been supposed that some of these difficulties may be got over by treating a large library as an amalgamation of small ones. It has been suggested, for instance, that in so immense a collection as the British Museum there should be librarians for separate parts of it—one for the theology, another for the law, a third for natural history, a fourth for medicine, a fifth for mathematics, and others for other branches. To this it has been answered that, practically, another kind of division is not only preferable, but in some cases imperative. There are books on medicine, for instance, in the Museum not only in English, Latin, French, and German, which are the most ordinary languages for the subject, but in Spanish, Danish, Russian, Chinese, &c. A medical librarian, therefore, not acquainted with Russian and Chinese, would not be able to class or to catalogue the whole of the books in his department. On the other hand, a Russian scholar not acquainted with medicine or mathematics would meet with no difficulty, if of ordinary intelligence, in classing and cataloguing a Russian medical or mathematical volume.

The first requisite therefore for dealing efficiently with a book is to be able to read the title-page,—and often a great deal more than the title-page. In fact, at the Museum, though the different assistants of the Printed Book department are all officially reported as engaged without distinction in "assisting the keeper of the printed books," it has been found in practice necessary to have one to catalogue Hebrew and another to catalogue Chinese; and books in certain other languages, Slavonic or Oriental, only go to particular persons. As there are more than twenty cataloguers, a division can easily be made; but the difficulty recurs in the case of operations which are confided to one or two persons only. The books to be sent to the binder, for instance, are sent by one assistant, and the letterings to each book are to be in the language of that book. The course necessarily taken is, for the assistant to write the letterings in as many languages as he can, and to apply in cases of difficulty to those of his colleagues who can assist him. The binder himself is often in a perplexity, and obliged to ask for information; for, it must be remembered that the printed directions to the binder given in books at the Museum are couched, of course, in the language of the book—Welsh or Wallachian, as the case may be. As the library is now arranged in different classes, and each book is placed according to its subject, it is of course necessary, also, for those who place them to read at least the title of each, or to have the title translated for them. In short, in all the operations of a library, from first to last, and more especially of a large library, the question of language is continually recurring,—although, strange to say, in outside speculations on the subject of library management, it appears to be continually overlooked. It may be doubted if Mr. Gladstone, when he recently told the House of Commons, as Chancellor of the Exchequer, that the duties of the assistants in the British Museum were so easy and agreeable, that their salaries might well be proportionably light, remembered at the moment that it was part of those duties to catalogue Sanscrit and Chinese.

In addition to qualifications of this kind, it is especially required in those who are entrusted with the selection of books to be purchased for a large library, that they should have an acquaintance with bibliography in general. The name of no other science has been so misapplied as this. To call a man a bibliographer because he is well acquainted with the productions of the press of the Alduses and the Elzevirs is as absurd, however frequently done, as it would be to call a man a geographer because he was familiar with the topography of the weald of Kent or the coast of Sussex. Bibliography is the knowledge of the world of books, as geography is the knowledge of the world of sea and land. The ramifications and details of the science are infinite; but it is no more the business of a bibliographer to know every detail of a set of volumes than of a geographer to know every street of a market-town.

When it is determined what books are to be acquired, the method of acquiring them comes next into consideration. The best and most rapid method of increasing a large library has often been said to be the purchase of collections in a mass. There can be no doubt that, if it be determined to form a library of one or two hundred thousand volumes, and a good collection of forty or fifty thousand occurs for sale, it will be expedient to secure it to begin with. There are certain books that may be expected to be found in every considerable collection, and to acquire them by thousands is a saving in point of time to acquiring them one by one. But this very circumstance renders it impossible to proceed in the same way. If a second collection, still more if a third or a fourth, be bought in a mass, there is a certainty of acquiring duplicates, triplicates, and quadruplicates. It is true that in the history of several of the great libraries we find this proceeding recorded as having taken place. The library of Vienna, we are told, was enriched on the decease of its librarian Blotz by the books which had belonged to Blotz, on the decease of his successor Tengnagel by those of Tengnagel, and on the decease of his successor Lambecius by those of Lambecius. It is evident, however, by the mere statement of the facts that they involve a dilemma. Either these acquisitions brought duplicates to the library by wholesale, or else during the lifetime of Blotz, Tengnagel, and Lambecius, the collection of which they were the guardians must have been deficient in the very books which they esteemed worthy of a place in their own libraries, and thus the addition of a valuable set to the imperial collection must have depended, not on the life, but on the death of the librarian. It is, in fact, a strong censure on the composition of any great library, that it should be possible to add a large well-chosen collection to it without adding a mass of duplicates. There may be occasions on which, not to let an opportunity escape, it may be advisable for the possessors of a large library to buy another in a mass, but in that case it will be necessary to sell again immediately most of what has been purchased.

The additions to a large well-chosen library will thus have to be made in detail. This will more particularly be the case with the current literature of the day—a kind of literature which has been perhaps more frequently overlooked in large libraries than any other from the time of the invention of printing downwards. There has been a singularly obstinate delusion, that it might be safely neglected because procurable at any time—a delusion which, much to the advantage of posterity, appears to be giving way. The method of arriving at a knowledge of this literature is easy and obvious. To Germany and its booksellers we are indebted for that simple but invaluable invention, the catalogue of all the new books published at certain intervals, which was first exemplified in the catalogues of the fairs of Frankfort and Leipzig—one of the earliest forms of periodical publication, the first of these lists being 101 years antecedent to the 'Journal des Savans,' which was the first review. Separate editions of them were apparently issued for different countries; for we have seen in the British Museum a Leipzig catalogue for part of 1623, in which a long list of English books is given, which does not occur in the ordinary German copies. No other periodical catalogue of English books so early as this is known; Maunsell's, which preceded it, being not of a periodical character. It is the earliest member of the family which was represented by 'Clavell's Lists' in the time of Charles II., and now by 'Bent's Advertiser' and the 'Publishers' Circular.' Publications of the same nature are now issued in nearly every European country; and by inspecting the whole, and giving orders from each, it is practicable for any library provided with the indispensable requisite, liberal funds, to collect under one roof in an unbroken flow the whole mass of current European and American publications of value, without any other agency than that of the ordinary book-trade.

Books published for sale may be divided into those which are on sale by the publisher, and those which are "out of print," according to the technical phrase; that is, into those which are procurable at once if an order is given to a bookseller, and those which can only be acquired when an opportunity occurs, at sales by auction or otherwise. The purchase of a book when it is on sale by the publisher is the simplest method of acquiring it, but it is supposed not to be the most economical, because by waiting it may generally be obtained at a lower price. In many cases, however, it is the most economical also; for if there be a demand for a book, and it becomes out of print, the price of it immediately ascends, and sometimes to an extravagant height. In England, and still more in America, a book passes so soon out of the hands of its publisher,—such violent measures are sometimes adopted to get rid of it in the way of a "remainder,"—that those who do not buy it on its first appearance may often afterwards inquire for it in vain. In Germany a different and less hurried system prevails: the stock of a bookseller often passes from generation to generation, from century to century, and some books may be ordered from the publisher in sheets a hundred and fifty years after their first appearance.

The great majority of books are of course those not procurable at first hand, those which are only accessible through the medium of the second-hand bookseller—in Germany he bears the more respectful name of "antiquarian" bookseller—or the sale by auction. It is a question of some importance whether the best method of acquiring these is through the bookseller or the auctioneer. The first method is obviously the most simple, and to the purchaser by far the most convenient. The price of the book—a most necessary element in the decision on its purchase—is known beforehand; the book is also generally sold with a guarantee of its completeness. On the other hand, at a sale it is necessary for the intending purchaser to decide what price he will go to, a decision which cannot in many cases be arrived at without considerable trouble, and which is after all almost certain to be repented if the book happen to be sold a little over. It is not uncommon, also, to sell books at auctions with all faults or errors of description; and, in any case, to return a book purchased at an auction is a more circuitous and troublesome process than to return one purchased of a bookseller. It is also exceedingly inconvenient to attend or procure attendance at the time and place of sale. Under all these drawbacks, it is somewhat surprising that purchasing books at sales should be so popular, that it is becoming a common remark among booksellers that books which they have long offered in vain in their published catalogues go off at once at higher prices when a copy occurs at an auction. It might have been accounted for more easily during the period of bibliomania at the beginning of the present century, when it was customary for amateurs and collectors to attend in person at sales, and the Valdarfer Boccaccio, for instance, was contended for by the Marquis of Blandford, Earl Spencer, and others, in the auction-room. The scene was so dramatic, and the excitement so contagious, that the contest for an old folio might arouse the passions as well as the chase after a fox. The case is altered at present, when the biddings are made by booksellers or their commissioners, and the prices which purchasers are to give are finally decided upon beforehand, in the cool of the study instead of the heat of the auction-room. Still the highest prices which are now obtained for books are generally given at auctions, and the lowest prices at which books are sold are also taken at auctions. But for this latter circumstance—as the innovation has now been attempted of publishing a book by auction—there would be some danger that the trade of a bookseller behind the counter would cease. Both bookseller and auctioneer still continue, and if either is destined to become extinct, it is to be hoped, for the sake of purchasers, it may be the auctioneer.

A proposal has recently found favour in the eyes of some for acquiring books for public libraries by means of exchange. To substitute exchange for purchase is simply a return to barter, which is not considered advisable by political economists in other cases, and of which no peculiar benefits have been pointed out in connection with the trade in books. The advocates of the measure appear, in fact, to forget the advantages of a circulating medium. If, as they allege, some libraries are encumbered with duplicates, and at the same time labour under a deficiency of funds for purchases, it would seem obvious that a simple method of escaping from the double difficulty would be to sell the duplicates, and with the proceeds purchase what was wanted to as great an extent as the funds allowed. If instead of selling and buying, librarians put themselves into the hands of an agent to exchange their books for other books in the possession of some other library, they depend in a great measure on the agent's sagacity and honesty, and unless the books in the possession of both the contracting parties happen to be exactly equal in value, there must after all be some money exchanged; as, indeed, in all cases, some money must pass in recompense of the services of the agent. The plan has been tried, at the suggestion of the agent, M. Vattemare, between France and some of the States of America, and some of the American states have expressed themselves satisfied: but this measure of success in the experiment does not seem likely to lead to its wider adoption.

Public libraries of great importance have been endowed in almost every country with the legal right of demanding gratuitous copies of every book published in the state to which they belong. The history of the right and its limitations in various countries is treated of at some length in Edwards's 'Memoirs on Libraries.' From the earlier part of this century up to 1836, eleven copies of every book published in England, Scotland, or Ireland, had to be delivered to different public libraries in the three countries; but by an act of parliament of that year the number was reduced to five, of which that to the British Museum was to be delivered at that institution without being demanded, under penalty in case of neglect of a fine of five pounds. The complaints against the "copy-tax," as it has been called, have often been very loud, though the imposition is extremely moderate when compared with the tax on patents, to which it bears a close analogy. It may be doubted if any superior method could be pointed out, to form a complete collection of the products of the press. It has been said that acquirement by purchase would be as much more effectual as it would be more agreeable to all parties. But is this well established? The publisher of a local halfpenny newspaper is seldom found to keep a complete set of his own journal, the trouble of doing so is not compensated to him by the price. There is much more chance of his attention being aroused by the danger of being fined five pounds than that of losing a halfpenny. The 'Bibliographie de la France,' published weekly at Paris, is a record of the copies of books sent in obedience to the law, to the office for receiving the legal deposits. It is extremely common when orders are given to booksellers in Paris for some of the smaller and cheaper works recorded in it, to receive for an answer that it is impossible to procure them, that publishers in the provinces will not take the trouble to send them, or that printers in Paris will not take the trouble of looking them up. Those, therefore, who are anxious to see preserved one copy at least of the "fugitive literature" of our times, will not regret that the legislature has supplied a powerful motive for publishers to attend to the supply of the national library.

A somewhat new light has been thrown upon the matter by recent transactions in America. The copy-tax was partly abolished last year in the United States, on the petition, not of the publishers, who are usually spoken of in England as the aggrieved parties, but of the librarians, on whom devolved the trouble of collecting it. In February, 1859, by an Act of Congress, it was determined that for the future one copy only instead of three of each book published in the United States should be required of the publishers, to be deposited in the "department of the interior," and that the Smithsonian Institution should be exonerated from the duty of receiving and preserving copies, which was considered a burthen rather than a benefit. The conduct of Sir Thomas Bodley has thus been selected for imitation by American librarians in the very point in which it was a warning instead of an example.

When books have entered a public library, one of the first operations usually performed on them is to mark them as the property of the institution by a stamp. The stamp in many cases bears the name of the institution only; it is now, by a simple but ingenious contrivance, made at the British Museum to bear also the date on which the stamp is affixed. The uses of this are manifold. It is sometimes of consequence, even in a legal point of view, to ascertain the exact date on which a book entered the Museum—it is a proof that on that day, if not before, the book was published. In the old Thomason collection of tracts, the collector noted on the title-page of each pamphlet the day on which he obtained it; and Mr. Masson, the biographer of Milton, will thus have it in his power to ascertain the exact date of issue of several of Milton's publications, some of which were given by the poet himself to the collector. A similar end is contributed to by a regulation now adopted with regard to the Museum bindings. The cover of every pamphlet, and of every number of a magazine, is bound along with it. The 'English Cyclopædia,' which the reader now has before him, is issued in monthly numbers with covers: when the volume is bound the covers are generally removed by the binder and destroyed. There are at the British Museum more copies than one of this Cyclopædia, and in that which is obtained by the copyright law, the covers are bound up with the text, and not at the end of each volume, but at the end of each number, so that in the bound volume the light-brown covers meet the eye at certain intervals in the midst of the white pages. An eminent Spanish bibliographer, who was visiting the Museum a few years ago, complained of the unsightliness of this practice in regard to some modern Spanish books he was examining, and it was pointed out to him that the covers in that case contained a portion of information which occurred nowhere else, and was thus preserved for perpetual use. Struck with the circumstance which he had overlooked before, he was silent for a minute, and then declared that on his return home he would take care to adopt the plan in his own books, and mention it elsewhere, for that otherwise it was likely that the British Museum would in a few years contain unique copies of most of the books which it imported from Spain.

The question of the catalogues of public libraries is one that has been much debated of late years both in England and France. A portion was issued in 1841, of an alphabetical catalogue of the library of the British Museum, in a folio volume, comprising the letter A; and a portion of a classed catalogue of the Imperial Library of Paris has been published since 1855, in six quarto volumes, comprising the history of France, and a part of the division of Medicine. These are the two largest libraries of which it has been attempted to publish a catalogue, and that of the Museum has not been carried further in print, though it is now advancing rapidly in manuscript, and will probably, in the course of 1862, be brought to a conclusion, that is, it will then be completed, in manuscript, on a level with the time. The immense acquisitions of the library throughout the period during which it has been carried on, have rendered it necessary to catalogue almost 400,000 volumes which were not in the Museum at the time that a commencement was made of printing. When the catalogue of more than 600,000 volumes is completed in manuscript, the question will again present itself whether it is to remain in manuscript or to be printed; and if printed, whether in a classed or alphabetical arrangement.

It seems to be generally assumed that the title-slip, or title-card, for a book, when once written, is only available for some particular form of catalogue—that it must necessarily be arranged in the order indicated by the heading, and no other. A moment's examination of the question will show that this opinion is by no means well founded.

Take, for instance, the following—a specimen of one of the Museum "title-slips," or written "billets," describing a book :—

598 i. Lingard (John).
History of England. 9 vols.
London, 1819–40. 4to.

The mysterious "598 i." to the left is what is called the "press-mark," —that is, the indication of the locality in which the book stands : which, in this instance, is in the press or book-case marked 598, and in the ninth shelf from the top of that press, the successive shelves being marked by the letters of the alphabet, a, b, c, &c., in regular order. The use for which this title-slip was originally written was that it might be placed in the alphabetical order of the author's name, "Lingard," and thus form a component part of the great alphabetical catalogue of the authors' names. But in addition to such a catalogue as this, the interior management of a large library imperatively requires another, which is generally termed a hand-catalogue, but might more appropriately be called a shelf-catalogue—a list which indicates all the books of the library in the order in which they stand on the shelves, so that if a volume be missing there may be the means of ascertaining what it is. In most cases this hand-catalogue is made up quite separately, and to make it is a serious business. At the Museum, where four identical copies of every title-slip are now produced simultaneously by writing with a sort of stylus on prepared paper, it was proposed by one of the officers that one of these copies should be arranged in the order, not of the author's name, but of the press-marks, by which, *ipso facto*, a shelf-catalogue would at once be produced with the minimum of trouble. Directions were given to do so, and a hand-catalogue was and is produced accordingly without the application of a particle of skilled labour more than is requisite to read the letters and figures. In the recent part of the Museum building, a shelf-catalogue presents another advantage of some moment. As, by an arrangement which will be described a little further on, the books are classed on the shelves, those who consult the shelf-catalogue of the presses which are assigned to the history of Spain, the topography of Switzerland, the science of pneumatics, or any other subject, find assembled the titles of all the books on that subject of recent acquisition which the Museum possesses,—they find, in fact, in the shelf-catalogue, a sort of rough classed catalogue. The success of the new arrangement led the officer who proposed it, Mr. Watts, to suggest, in 1855, a further extension of the principle. The name of a book is often remembered without remembering the name of the author. This is so often the case with regard to plays and novels, that in the catalogues of circulating libraries intended for practical use the name of the book is generally taken by preference. To meet this want, Mr. Watts proposed to arrange a copy of the title-slips in the alphabetical order of the words which immediately follow the author's name. Thus, the 'Rejected Addresses' of Horace and James Smith would be found in one catalogue in the order of the word "Rejected," while in the other they would figure under the name of the Smiths. To search for anything in the present Museum catalogue amid the names of the multitudinous Smiths, is in itself so tedious a task that the book would certainly be in general looked out with much more ease under its own title; and it may be added that as some of the editions were published with the authors' names and some without, the proposed catalogue would have the advantage of assembling them all under 'Rejected Addresses,' an advantage which would be extended to all books in the same semi-anonymous predicament. All 'Histories of England,' all 'Strangers in London,' &c., would be brought together, whatever might be the names of the authors.

A fourth copy of the title might be used to make a fourth catalogue, of a kind analogous to that of early books in Panzer's 'Initia Typographica.' In this catalogue the title-slips would be arranged in the alphabetical order of the places of printing, and those of the same place of printing would be arranged chronologically. To local antiquaries, or to local inquirers of any sort, this would be a material assistance. It might be seen at once without difficulty what books the Museum contained printed at Norwich, or St. Alban's, or Aberdeen, or Belfast; or, to take a wider range, at the Cape of Good Hope, or Madras, or Melbourne. By looking at Pesth, or Lisbon, and a few other sub-divisions, it might be ascertained with ease what were the latest accessions in Hungarian or Portuguese literature. With Paris and London, under which the entries would be excessively numerous, the gain would be great. A reader might trace the gradual progress of printing in London from Wynkyn de Worde onwards; might look up what books were issued in the first year of the Reformation, in that in which Shakspere came to London, in those of the protecterate of Cromwell, in that of the Revolution! Macaulay would have found in a body all the plays, and the ballads, and the nonjuring divinity, and the political pamphlets, that were poured forth in town in 1688; and then, turning to the volume of Dublin, all the products of that stormy year in Ireland. There is hardly a literary man who would not have some desire of this kind to gratify, and to many it would present ready to their hand a mass of materials on various historical subjects, which they would otherwise scarcely think of looking for. This kind of information is at present inaccessible, except at the expense of tedious research. That valuable but very imperfect book, Cotton's 'Typographical Gazetteer,' might be at once corrected with ease in a hundred passages. Such would, it is supposed, be the benefits of this new method of making use of the duplicate title-slips of the Museum. If, instead of four copies of the title-slips, there were twenty (which might be cheaply produced by the aid of printing or lithography), other catalogues might be evolved. There might be lists of all the accessions to the Museum, in the order of their arrival. There might also be catalogues of books arranged according to the languages in which they were written, so that those who only sought English books need not turn over page after page of Latin or French titles, and those who sought for German or Russian might at once find what they sought. There might also be special catalogues of particular classes: of English plays, or English novels, or books on vellum, or books with autographs. In short, without any additional trouble as to cataloguing, the mere "shuffling of the cards," or title-slips, the mere different arrangement of them by ordinary hands, might produce a variety of catalogues which would secure to every reader a number of different ways of looking for any particular book or class of books he was in search of.

Were the title-slips thus put in print, kept standing in type, and a catalogue occasionally issued of, for instance, the books added to the Museum which were printed in the years from 1851 to 1860 inclusive, the list thus formed would be of much value. It would be the most copious list of English, Scotch, and Irish books of the period embraced. In the so-called London catalogues much is passed over that is issued in London,—plays and Quakers' books, and Roman Catholic and Swedenborgian and Mormonite literature, reports of charities and societies, catalogues of exhibitions, and numerous other kinds of publications, including of course privately printed books, many of which come to the Museum as presents. In addition to this, there would be a select list of all the principal publications of Europe, from Lisbon to St. Petersburg, and of America, from Montreal to Buenos Ayres. Such a list of about 100,000 volumes published within ten years, would not only be an interesting memorial of the progress of the Museum, but a useful handbook to the lover of bibliography.

The classification of books in a catalogue or in a library is a subject that has often been discussed. To classify in a catalogue is of course an easier task than to classify on shelves; the titles are all of one size, and may be shifted or shuffled at will, but the volumes are sometimes heavy materials, and hard to move, and are of all sizes, from the 'Bijou Almanack,' to the great 'Dutch Atlas' in the British Museum, nearly six feet high. When the learned Lambecius, in the 17th century, arranged the books in the Vienna library according to their subjects, irrespective of size, so that a diminutive duodecimo sometimes stood side by side with an atlas folio, the appearance was so strange, and the quantity of space that was lost was so immense, that the first thing done by his successor Nesselius, was to re-arrange the books according to their sizes. It is often the case in the history of libraries that we find a new librarian carefully reversing all that his predecessor has done, but it does not follow that in all such cases the alteration is an improvement, as it seems to have been in this. The plans] for the classification of catalogues have multiplied to such an extent, that at last a classification of the systems is almost necessary. M. Achard in his 'Bibliographie' gives an account of several; the Rev. Mr. Horne in his 'Introduction to Bibliography' follows him, and increases the list; and Mr. Edwards in his 'Memoirs on Libraries,' not only pursues the subject to a still greater extent, but gives a tabular view of thirty-two of the contending systems. Many of these differ only in trifles, and some of them are utterly worthless and beneath discussion. The system which has in its main features been more followed than all the others together, is that which is called the system of the Paris booksellers. On this plan all literature is divided into five sections—Theology, Jurisprudence, Philosophy or the Arts and Sciences, Polite Literature, and History. The division Arts and Sciences is a sort of general receptacle for all which could not find a place in the others: the limits of the remaining four are tolerably well defined, and any great collection of books must always be divisible into them. Many of the other systems aim at changing the order of precedence of these divisions, but it obviously matters little if Theology be placed before or after History, Literature before or after Jurisprudence. It matters little also if the books on the history of France be placed before or after the books on the history of Spain, provided that in a large library the division of books on these two subjects is consistently made, and the books on each are carefully kept together. The really important differences are in apparently minor matters, on the question for instance which divides Francke in his catalogue of the Bünau library from most of his compeers. In a large library there will be numerous histories of the cholera in particular places, in Exeter, in Bologna, in Lisbon, in Linköping, in Moscow. According to Francke's system, all books of history in which a locality is specified, belong to the history of that locality, and thus a narrative of the cholera at Bologna will be put in the same subdivision with a history of painting at Bologna. According to most other arrangements, all histories of the cholera will form part of the division, "Medicine," in itself a subdivision of Arts and Sciences in the system of the Parisian booksellers, and all histories of painting will be classed under the "Fine Arts," another subdivision of Arts and Sciences. The question is a knotty one to resolve in the arrangement of a library on the shelves: in the arrangement of the entries of a catalogue, it is easiest answered by placing copies of them under several divisions.

The method of arranging books in a library has also been the subject of much consideration. Great importance has been attached to the opinions of Della Santa, a Florentine, who gained a reputation by the original ideas which he promulgated in 1816 in an ingenious pamphlet on the subject of libraries. Della Santa was the first to attack with force of argument the old and favourite notion that it was necessary to accommodate a library, like a picture gallery, with a suite of elegant apartments fit to be shown to strangers; and he proposed instead that a collection of books should be packed as closely as possible in the most convenient proximity attainable to a reading-room, to which alone any attention need be given for mere appearance. He also maintained the proposition that the attempt to arrange books in any kind of scientific order was a "mockery, a delusion, and a snare," and certain to lead to nothing but confusion. His doctrine was that it did not matter in the slightest degree where a book was placed provided it could be found on the instant by means of its press-mark, and that all scientific arrangement should be reserved for the catalogues. The same views have been advanced in a pamphlet in both French and Russian, by M. Sobolshchikov, one of the librarians of St. Petersburg, published in 1859; and it appears that the library of St. Petersburg is arranged, if it may be so called, on this principle of non-arrangement. The books are placed on the shelves without any attempt to class them, and the press-mark is all in all. It has been already explained in another article of this Cyclopædia [BRITISH MUSEUM], that there the attempt to class the library has been made, and is considered to have succeeded. Certain it is that while the books are, by means of the press-marks, found by the attendants without any difficulty, the different classes of books are kept together in scientific order, and that as fast as fresh books on any subject come in, in any quantity, they are placed side by side with their predecessors of the same class. The method which is adopted is to have presses or bookcases of equal size, so that the books in one can be shifted when required into another, and to have the number-marks of the presses loose and removeable, so that when the books are shifted, the number-mark may be removed with them. Thus the books on chess will constantly stand in press 7915, though press 7915 may at one period stand in the north-east wing, and at another period in the south-west. The numbers of the presses are inconsecutive, so that though the presses always stand in the order of sequence, the opportunity is left of inserting between any two of them such additional presses with appropriate numbers as the increase of the library may render requisite. At Berlin, the same freedom of movement and fixedness of marks are aimed at by a different method; instead of the presses it is the books which are numbered with inconsecutive numbers, a plan which is followed at the Museum, in marking the periodical publications, but is found to present many inconveniences which are avoided by the other system. When applied to single books it certainly imposes much more trouble on the librarians, and does not lessen the labour of the attendants who have to find the books by the press-mark. A favourite system in Munich, and many of the continental libraries, is to divide all the books into about forty different sections, such as Ancient History, Jurisprudence, &c., denoted by the letters of the alphabet, single and double, to take the books of each class according to their sizes,—folio, quarto, and octavo, or under, and to arrange them in alphabetical order according to the authors' names or other headings. Thus, if a 'Lingard's England' be wanted in quarto, the librarian goes to the range of quartos in the division History, and finds it in its alphabetical order under the letter L. In such an arrangement volumes with authors' names may be found even without the aid of a press-mark and a catalogue; but in the London Institution in Finsbury Circus, which is mainly arranged on this principle, it was thought some years ago that press-marks might be usefully added.

One of the great differences in the management of libraries consists in the regulations of admission. In foreign public libraries in general admission is given at stated times to all who present themselves, subject to certain rules as to age, dress, and demeanour; in the Chetham library, at Manchester, and in the "Free Libraries" which have been recently established in England, the rule is the same; but in other English institutions, and even at the British Museum, admission is more restricted. At the Museum it is necessary, in order to procure a reading-ticket, to apply for it in writing to the principal librarian, and to send in conjunction with the application a letter of recommendation from a householder. Practically a ticket of admission has for many years past been in the reach of almost every one who chose to take the trouble of applying for it, but some complaints have been made of the illiberality of requiring any ticket at all. Several years ago, in 1836, a suggestion was made by a writer who is now an officer of the Museum, that two distinct reading-rooms should be provided, one open to the public in general, like the galleries of Antiquities and Natural History, the other as before for readers who had received a ticket from the principal librarian. The public reading-room was to be provided with a separate catalogue, to contain every work of use and information, but not works of exceptional value. All those who entered it would thus have access, for instance, to several good editions of the works of Shakspere, but not to the early quartos of his separate plays, which are often worth more than their weight in gold. The readers with tickets in the special reading-room would have the same catalogues as at present, and would, as now, be able to have anything they pleased. This plan of two distinct reading-rooms for one library has never been entertained in England, but it was proposed in 1858 in France, by M. Prosper Mérimée, in a report on the imperial library in Paris, and adopted forthwith by the Emperor, who gave orders that it should be carried into effect in the new buildings for that library now in course of erection. The complaint at Paris had been precisely the reverse of that at London. It was, that by indiscriminate admission of the population of Paris it was found that those who wished really to study were placed at a disadvantage—that the tables of the reading-room were often occupied in winter by those who came merely for the sake of warmth, and some of whom might be seen holding a book in their hands bottom upwards. The universally open reading-room would be the novelty at London, the select reading-room will be the novelty at Paris—at least as a part of the regulations, for we can report from personal observation in 1840, that at that time little knots of select readers were admitted to a librarian's table in an inner room. It may be observed that, with all restrictions, some classes of readers are more numerously represented at London than at Paris. There are more ladies, in proportion, in the Museum reading-room, where there are two tables provided for their exclusive accommodation, and where they are also at liberty to take their seats at any other table. At the new public library at Boston, in Massachusetts, attention to the fair sex has been carried still further, as a separate room is provided for them with a hundred seats, while the reading-room for the gentlemen has no more than twice as many.

There has been occasional discussion for many years past in London respecting the advantages of an evening reading-room at the Museum, the evening being undoubtedly the time at which the other literary institutions of London are most frequented. The main objection to it appears to be the risk of conflagration, and it was suggested that the evening reading-room should be in a building entirely separated from the main body of the library, except by a narrow well-guarded fireproof passage, easily to be cut off from communication in case of fire. In the magnificent reading-room in the centre of the Museum, which has since been erected at Mr. Panizzi's suggestion, the light of day is admitted by a range of twenty lofty windows, through which if necessary the light of gas might be admitted at night, the gas being in standards outside, and at some distance from the building. Abroad, the question has been solved without these precautions. The library of St. Généviève, at Paris, which was rebuilt in 1851, was constructed with an express view to the employment of gas, and the magnificent room which contains it, one of the finest library rooms in the world, is now open in the evening throughout the year. At the library of St. Petersburg the hours have also been extended from ten in the morning to nine in the evening all the year round. In high northern latitudes, to exclude the use of light and fire, as is done in many of the libraries of Italy, would be to limit most materially the utility of such institutions; some alteration in that respect is demanded by the climate; but it seems surprising that, with the great calamity of the conflagration of the Winter Palace before them, the authorities at St. Petersburg should be bold enough to risk the destruction of their immense repository of literature by unnecessary daring. A separate reading-room for the time of artificial light would afford an additional security which it would surely be no idle precaution to take.

The question if books should be lent out from great public libraries is generally decided differently in foreign countries and in England. It is perhaps a consequence of this that "circulating libraries" in their modern sense—that is, shops in which books are lent for hire—are, apparently, an English, or rather a Scottish, invention. In their larger sense they may be traced as far back as the days of St. Jerome, in the 4th century. St. Jerome expressly mentions that St. Pamphilus, presbyter of Cæsarea, who died A.D. 309, made a collection of books amounting to 30,000 volumes, chiefly of a religious character, with the object of lending them out to religiously disposed people to read. "This," says Dr. Adam Clarke, "is, if I mistake not, the first notice we have of a circulating library." There are, however, some traces in Aulus Gellius that it was permitted to borrow books from the public libraries; though probably the usage of having libraries at the public baths, where so many of the people spent their time, and the habit of living in public common among the ancient as well as modern nations of the south, made it far from a prevalent practice to borrow books to read at home. In the middle ages there are frequent traces in the history of the universities of Bologna and Paris that it was customary for booksellers to lend books for hire to the students, who would otherwise have hardly been able to obtain the requisite number for study. In Busch's 'Handbuch der Erfindungen,' circulating libraries are said to have been originally invented by Dr. Franklin, when a journeyman printer at Boston, in 1720. In 1720, Franklin was a boy of fourteen, and the institution that is meant is doubtless the subscription library established by him at Philadelphia in 1731, which is generally considered as the earliest subscription library, but the invention of which is not unequivocally claimed for Franklin in his Autobiography, though the terms which he uses are consistent with that supposition. The first circulating library in Great Britain is said in the 'Picture of London,' to have been begun by Allan Ramsay at Edinburgh in 1725, the year in which he published the 'Gentle Shepherd.' They were not introduced to London till 1740, by Batho, a bookseller in the Strand, and in 1770, according to Timperley, there were only four circulating libraries in London and its neighbourhood. From that period the new institution must have advanced with rapidity. It is now general throughout Europe, though England and Germany are perhaps its most congenial soils. It has had the effect of fostering the production of a peculiar species of literature—the "circulating library literature"—which was once at all events, flimsy and ephemeral to a proverb.

Many of the London libraries of this kind were, even in the 18th century, of considerable dimensions; but an establishment of this class has been developed by Mr. Charles Edward Mudie, in the space from 1840 to 1860, into quite a new stage of influence and importance. Mr. Mudie, by taking hundreds and even thousands of copies of particular books, is enabled to supply at his, not their risk, the demand of country circulating libraries which are in communication with him, and it sometimes happens that two rival establishments in a country town both announce that they are connected with Mudie. Even the second largest library in London—that of the London Institution in Finsbury Circus,—takes out a subscription of 100*l.* a-year to procure from Mudie the temporary loan of such volumes as the management does not think worthy of a permanent place in the collection. His influence was even beginning to extend abroad, and his books to circulate at Paris, by means of a branch establishment there; but we believe that this has been abandoned in consequence of the difficulties occasioned by the Custom House and the prohibition of some books in his catalogue. The development of this great establishment appears to have been fatal to innumerable book-clubs, or at least to have induced them to abandon the old plan, of selecting the books for themselves and disposing of them after use among their own members, for that of procuring them from Mudie, and of course returning them to him when they are read. One effect of the system not to be admired is that it substitutes the decision of a single purchaser for that of thousands; but as that purchaser's decision is a costly one, and made at his own risk, he is not likely to favour his own taste in many cases in opposition to that of the public. The great mass of the books, as soon as they begin to fall out of circulation, are disposed of at reduced prices, and it is on the terms on which this can be managed, and the adroitness with which it is effected, that the profit and loss of this vast machinery must depend. The announcements of the augmentations of the library have gradually swelled up to "150,000 volumes a-year;" but this of course affords no measure of what is the real augmentation, probably little more than 1000 volumes being annually added to the permanent stock. The establishment is almost as unparalleled of its kind as its near neighbour—the British Museum.

Another large circulating library in London is of a different constitution and superior order—the London Library, in St. James's Square, established by a society of literary men, who by the payment of an entrance-fee and an annual subscription, or by an annual subscription alone, obtain the right of borrowing books from a library which comprises, among other volumes, the folios of the 'Acta Sanctorum.' The London Library is, in fact, a proprietary library of not an unusual type, except that the circulation of its volumes is made the prominent feature. The now extinct Surrey Institution and Aldersgate Street Institution also circulated their books, and the Russell Institution is constituted on the same plan.

When several establishments of this kind exist in a capital, there is certainly less inducement to allow the books which belong to the national library to circulate beyond its walls. Mr. Panizzi, both when Keeper of the Printed Books at the British Museum, and when Principal Librarian of that establishment, has often expressed his opinion before committees of the House of Commons and elsewhere, that it would be advisable to form supplementary institutions in different parts of the metropolis, to relieve the Museum of some of the present pressure on its resources. Should auxiliary libraries ever be formed, consisting, of course, of books of which in every case other copies might be found at the Museum, the plan might then, perhaps, be entertained with advantage of circulating the books of these libraries, as in case of loss, the loss would not be so serious. But with regard to a great national library, the preservation of books is as main an object as their collection. Such a library is not for the use of one generation only,—in fact, some of its uses are only developed by its passing into the hands of successive generations. It should be exposed to no other risks than such as are absolutely inevitable. The testimony of Molbech, the librarian of the Royal Library at Copenhagen, where lending is permitted, is to the effect, not only that the risk is greater, as must of course be the case where the books are removed from supervision and control, but that in practice great damage is found to ensue. It would, perhaps, be expedient to examine the subject more closely before a final determination was come to on either side; for while the Bodleian library is strictly non-circulating, the books are freely lent out to the members of the University from the University library of Cambridge, and yet any material difference in the condition of the two libraries, to the disadvantage of that of Cambridge, is certainly not a matter of public notoriety. Even if it should be found inadmissible to adopt the freedom of borrowing practised in foreign libraries, and the want of which in England is so loudly complained of by foreign scholars, a proposal made in 'Fraser's Magazine' for June, 1860, by Mr. Spedding, the editor of Bacon, might be taken into consideration. Mr. Spedding proposes that if a scholar in London be desirous of consulting a manuscript or rare book in the Bodleian, not existing in the Museum collection, he shall communicate his wish to the Oxford authorities, and they, if they entertain his application, shall transmit the books required, not to his or to any private address, but to the authorities of the British Museum, who shall retain the book for a certain period in their custody and send it to the Reading Room, under the same guardianship and supervision as their own books. Of course, under similar circumstances, a book might be sent from the Museum to the Bodleian, and there might be a certain number of libraries with which the communication should be kept up. By this ingenious arrangement some of the advantages proposed by the lending system would certainly be afforded, under safeguards not now obtainable; but there would still remain the strong objection, that a reader wishing to examine a particular book known to be in a particular library, might be subjected to a disappointment which he now is in no hazard of. This objection is tersely stated in a passage from a letter by Niebuhr, which was quoted by the commissioners for examining into the University of Oxford. "It is lamentable," writes Niebuhr from the University of Bonn, "that I am here much worse off for books than I was at Rome, where I was sure to find whatever was in the library, because no books were lent out; here I find that just the book which I most want is always lent out." There are few libraries from which books are lent of which stories are not current respecting the abuse of the privilege, of volumes kept for years by persons too high or too venerable to be questioned. The rules of such institutions are often laxly observed by those from whom we should least expect such disregard. In Walter Scott's correspondence with Southey there is a passage in which he recommends him not to show publicly a book which he had sent him, because it belongs to the Advocates' library, and it is forbidden for those books to be sent out of Scotland.

Our theme has hitherto been public libraries, but the observations which have been hazarded with regard to purchasing, arrangement, and cataloguing will be applicable, with some alterations, to private libraries also. In many countries in which great private libraries have been once prevalent, and diffused a useful light, the rising of a great public library has dimmed their lustre, and even occasioned their extinction. Many a smile has been excited by the maxim of the enthusiastic engineer, that rivers were made to feed navigable canals, but it may be well maintained that the chief use of private libraries, after they have run their course for a generation, is to feed public collections. Nothing can be well more misplaced than the regret expressed by Evelyn and others at the non-continuance of libraries as heir-looms in certain families. If, indeed, a private library be generously opened as some have been to the application of every scholar, and be made subservient to general use, nothing better can be wished for while it lasts, but a library like this, though nominally private, is in reality a public one. So, many a nobleman's park in the country, which is open to his neighbours, is as conducive in its degree to the public benefit as one of the public parks of London. But the case is different when, as with Beckford at Fonthill, a proprietor surrounds his estate with a high wall, and shuts himself up in selfish magnificence, and in England the instances are few in which private libraries have been other than private. But even if liberality in this respect had been much more frequent and conspicuous than it has been, it is surely a far more healthy state of things that in future it should be looked to as a staff, and not as a crutch; that progress in literature should be released from dependence on the favours of the great. In the case of a private library which is given or bequeathed to public use, the collector is a public benefactor of a high order; in the case of one which is broken up at its collector's death, its breaking-up may possibly be just as useful as its collection; in the case of one kept in private hands for generation after generation, it is more than probable that an injury is done to the public by withdrawing from public use what is not turned to private account. Among the many memorable circumstances connected with the sale of the memorable Valdarfer Boccaccio in 1812, perhaps the most striking is, that the purchaser, who gave the highest price for it ever given for a book, had at the time, unknown to himself, another copy in his own library, which had descended to him by inheritance. The only instance in which it would seem desirable that a great private library should remain in a family is in the case of a great author. It seems an appropriate tribute to his memory that Sir Walter Scott's collection should be kept entire at Abbotsford, but to keep the library of an ordinary collector together in respect to his memory, is not at all justified by the case of Scott. The monument which is erected to him in the centre of Edinburgh might as well be quoted as a justification for the ostentatious columns in honour of aristocratic landlords, which it is now the practice to raise from the so-called voluntary subscriptions of their tenants. To be incorporated in a public library, or rather to be distributed in several, is the proper "euthanasia" of a private collection.

Having thus examined the composition of a library of the very first order, and the rules that have been proposed for collecting and managing such a library, with a view of making it of the utmost possible public benefit, it remains to take a general survey of libraries, not in the abstract, but the concrete,—of the history and statistics of such collections as have from time to time been formed.

The most ancient library of which we have any authentic account is that of Osymandyas, king of Egypt, supposed by modern Egyptian scholars to have reigned about fourteen centuries before Christ. Diodorus Siculus, who gives a minute description of the monument of this king, mentions that there was in it a room containing a "sacred library," and bearing an inscription translated into Greek by *Ψυχῆς Ἰατρεῖον*, which has been playfully rendered "the Apothecaries' Hall of the Soul." Champollion believed that he had discovered this hall in the palace near Thebes, from which the "Memnon's Head" now in the British Museum was taken. It has been supposed that all the libraries of ancient Egypt were merely collections of sacred books; but a contrary inference may be drawn from the circumstance mentioned by Eustathius, the commentator on Homer, that Homer was absurdly accused by some ancient calumniator of having stolen his 'Iliad' and 'Odyssey' from a library in Egypt. It is singular that it was on the soil of Egypt that the most famous library of all antiquity afterwards arose. The first public library in Greece was formed at Athens by the enlightened tyrant Pisistratus, the supposed collector of the scattered poems of Homer; but according to the not very probable statement of Aulus Gellius, it was taken away to Persia by Xerxes, and only subsequently restored to Athens by Seleucus Nicanor, one of the successors to the Asiatic kingdoms of Alexander the Great. Another of Alexander's successors—Ptolemy, king of Egypt—established in Alexandria a great library, which continued under all vicissitudes the most famous library in the world for about 900 years. The most extraordinary statements are made by the writers of antiquity respecting the number of volumes it contained. Josephus relates that, on the question being put by Ptolemy, the founder, to Demetrius Phalereus, the famous Athenian exile, who had the superintendence of the library, what was the number of volumes, Demetrius replied that there were at that time 200,000, but that he hoped there would soon be 500,000. Aulus Gellius speaks of the number of volumes at a subsequent period as 700,000. There can be no doubt that, in this instance of counting, the "books" in a poem are taken as "volumes," and that the 'Iliad' would therefore be reckoned as 24, in which case it might be near the mark to assume that 700,000 volumes of the ancient library would contain about as much reading as 60,000 of a modern one. Even then the number is remarkably high for the early period of the history of literature at which the collection was made; and to account for it with any degree of probability, it is necessary to suppose that many copies of the same work were admitted, as was subsequently stated to be the case in the Mohammedan libraries of Egypt, and as was probably the case in all ancient libraries. This supposition is strongly supported by the subsequent labours of Aristarchus and the Alexandrian school of critics, who would naturally ground their improved readings on the collection of many copies of the same work. Allowance must also be made for that besetting sin in the enumeration of libraries, exaggeration; still the existence of exaggeration shows that there was something not too obviously scanty and limited to expend it upon. In the libraries of the middle ages we never hear of tens of thousands. Sixteen hundred years after the library of the kings of Egypt had been spoken of as possibly of half a million volumes, the library of a king of France was stated to contain 910. At the time that Josephus wrote, the library formed by Demetrius Phalereus and his successors no longer existed. In the wars of Julius Cæsar in Egypt, in some desperate struggles with the mercenary soldiers, the building in which it was kept accidentally caught fire, and the whole collection was consumed. The calamity was probably deeply felt by the most literary of conquerors, and in his 'Commentaries,' and those of his freedman Hirtius, there is no allusion whatever to the fact, which is however sufficiently established by the testimony of Seneca, Plutarch, Dion Cassius, Aulus Gellius, and Ammianus Marcellinus. Seneca, who refers to one of the lost books of Livy, speaks of 400,000 volumes as having perished. It seems, however, from various indications, that the library had increased so enormously previous to this conflagration, that the later part of it was kept in a separate building, in another part of the city, and thus escaped. Mark Antony, in his subsequent passion for Cleopatra, endeavoured to repair the loss of the early library of the Ptolemies by presenting to her the library of Pergamus, the collection next in celebrity to theirs. The kings of Pergamus had entered into a rivalry with the kings of Egypt in the collection of books, and the contest had been carried on so warmly that, according to tradition, the Egyptians forbade the exportation of papyrus, to which the Pergamenians responded by the invention of parchment, called from them Pergamena—the name from which the English one is derived. When Mark Antony presented the library to Cleopatra it amounted, according to Plutarch, to 200,000 volumes, and, being added to the preserved collection, formed thenceforth the new library of Alexandria, which continued the first in the world. The Romans, though Egypt was their province, respected its integrity; and when a conflagration destroyed the public libraries at Rome, the emperor Domitian contented himself with sending copyists to Alexandria to repair the loss. Its subsequent history is involved in much obscurity, and indeed many of the circumstances which have already been narrated are not established upon the most solid basis. There seems to be reason to believe that a great destruction of the library took place in the assault of the Christians on the temple of Serapis, on the triumph of Christianity over heathenism, A.D. 389; and the collection is asserted to have finally perished in A.D. 638, when the Mohammedans, under Amru, conquered Egypt.

The story told by Abulpharagius and doubted by Gibbon is well known: that Amru applied to his master, the caliph Omar, for a decision as to what was to be done with the library, and received the reply, that if the writings of the Greeks agreed with the Koran they were useless, and need not be preserved; if they disagreed they were pernicious, and ought to be destroyed; and that in consequence the books were devoted to the heating of the public baths. This massacre of intellect, if it really took place, was afterwards paralleled, if Arabic historians tell truth, by similar massacres of Mohammedan literature on the part of the Christians. At the capture of Tripoli, in Syria, by the Crusaders under the Count de St. Gilles, in the 12th century, a priest who entered the great library took down one of the books and found it was a Koran, a second and found it was a Koran, a third and fourth with still the same result, on which he exclaimed that the place was full of nothing but Korans, and fire was set to the whole collection, of which but a few volumes escaped. He had, in fact, says the Arabic historian, entered the room of the Korans, of which there were 50,000 copies in the library. Without of course accepting the statement of the number of Korans, it may be supposed that there was a large collection of them at Tripoli, and that the library was burned by the Franks on that account. Similar deeds are recorded of the Christian conquerors of Granada, and of Cardinal Ximenes, the patron of the Polyglott Bible.

The history of the libraries of ancient Greece is singularly obscure, and they seem never to have had any distinguished prominence,—a fact which is not in favour of the theory, that the civilisation of a people may be estimated from its public libraries. The library of Pisistratus has already been mentioned, its abstraction and its restoration by Seleucus. Its subsequent stay at Athens must have been short, for Sylla is recorded, on his conquest of Athens, to have carried off all the libraries to Italy, where, however, he does not appear to have given them to the Roman public, but to have left them to his son, who kept them in his villa at Puteoli. A story which is told by Plutarch in his Life of Alcibiades, affords a strong indirect testimony to the general existence of collections of books in connection with the schools at Athens. Alcibiades, it is said, was upon one occasion desirous of referring, when in a school, to a passage in Homer, and was told by the schoolmaster that he had no copy of the poet, on which, for his sole rejoinder, he gave him a box on the ear.

The honour of founding the first public library at Rome was reserved for Asinius Pollio, in the reign of Augustus, though Julius Cæsar is said to have entertained the design, perhaps as a compensation to learning for his involuntary destruction of the Alexandrian, and to have intended to nominate Varro as the librarian. Previously to Pollio, Lucullus is recorded to have been singularly liberal in opening his library to the use of the learned; and after him Augustus added two public libraries to the ornaments of the capital, the Octavian and the Palatine. Many others were added by subsequent emperors, who seem to have had a pleasure in attaching their names to new foundations, the most conspicuous and celebrated of which was the Ulpian, so called from one of the names of Trajan. These libraries appear to have had a great effect in diffusing over Roman society that literary air which is so remarkable a feature in the letters of Pliny, and which occasionally reminds the reader so strongly of the Paris of the 18th century. By some allusions in Ovid's 'Elegies,' written after his banishment, in which he questions if his new productions will be allowed to take their place beside the old in the public libraries, it appears that the new works of living authors found a place there, and this was probably the most effectual mode of publication. A few copies in the public libraries would probably—like a few copies in the circulating libraries of our own time—diffuse the knowledge of a new book more effectually than hundreds in private hands. At the same time, the frequent censures of Seneca and others of the "bibliomania" prevalent in his time, show that magnificent private libraries were then, as they have again begun to be in the last four centuries, a favourite means of expending and displaying wealth.

It is singular that of the great Roman libraries it is seldom mentioned of how many volumes they consisted or were supposed to consist. Julius Capitolinus, in his 'Lives of the Gordians,' mentions of the emperor Gordian the Younger, that he inherited the library of Serenus Sammonicus, his preceptor, and that that library amounted to 62,000 volumes, which is spoken of, as it well may be, as an enormous number. Another glimpse into the libraries of the period is given by the circumstance mentioned of the emperor Tacitus, that he commanded by a particular edict that the works of his ancestor, Tacitus the historian, and those of various other historical writers, should be transcribed in ten copies every year, and the copies distributed among the public libraries. In the time of Constantine the Great, the number of these establishments at Rome is stated to have been nine-and-twenty.

The tradition of the ancient libraries was continued by the Byzantine emperors through the long and dreary eleven hundred years which elapsed between the transference of the empire to that city, and its capture by the Turks. Constantine the Great founded a library at Constantinople, for the formation of which it is supposed that contributions were levied on the nine-and-twenty in the heathen temples at Rome. The passage is well known in the writings of Julian the Apostate: "Some are fond of horses, some of birds, and others of wild animals; but from an infant my mind has been possessed with a vehement fancy for acquiring and possessing books." Julian is recorded to have founded a public library in the grove of Daphne, which was the park of Antioch. Zonaras and Constantine Manasses relate a story of a library founded by the emperor Zeno, to which were attached a principal librarian, bearing the title of the "Œcumenical Doctor," and a body of twelve assistant-librarians, who were consulted as oracles in affairs of state; and they narrate that when the emperor Leo the Isaurian, the great iconoclast, found it impracticable to convert them to his opinions in favour of the destruction of images, he caused combustibles to be secretly laid round the building at night, and, setting fire to the pile, destroyed in one conflagration the library and the librarians. The truth of the narrative is supported by Baronius and some other Catholic writers, but it is now generally considered more than questionable. Photius, the patriarch, the contemporary of King Alfred, who in his 'Bibliotheca' of the date of a thousand years ago, so curiously anticipated the plan and utility of a modern Review, must at least have had access to the two hundred and eighty authors whom he analyses.

The Mohammedan antagonists of the declining Byzantine empire were according to their own accounts, on more than an equal footing with them in regard to libraries. The statements of Arabic historians on this subject seem in fact to belong to the 'Arabian Nights.' Quatremère, in his 'Récherches sur l'Egypte,' quotes several narratives which are altogether incredible as they stand, but which may be taken as grounds for believing the existence of libraries of a size and extent quite different from the contemporary collections of Christendom. Ibn Aby Tay, according to M. Quatremere, affirms that the library of Cairo contained 1,600,000 volumes, and was the largest in all the Mohammedan empire. M. Quatremere also tells us, on the second-hand authority of Ibn Ferat, that Tahia Ben-Aby-Tay, which seems to be only another form of the name of the same pseudo-historian, asserted that the library of Tripoli, in Syria, contained 3,000,000 volumes on theology only. The statements, to say nothing of their intrinsic incredibility, contradict each other. Makrizi, a better authority, speaking of the library of the Caliphs, describes it as filling forty chambers, and as containing 18,000 volumes on the sciences, and 2400 copies of the Koran.

The Arabs in Spain were the most literary of all the Arabs, and in their history we find mention of immense libraries, and also of bibliomania, a disorder of literature which indicates a general flourishing condition of the patient. According to Al-Makkari's 'History of the Mohammedan Dynasties in Spain,' translated by Gayangos, the inhabitants of Cordova were renowned, in the 10th century, for their passion for forming libraries. "To such an extent did this rage for collection increase," says Ibnu-Said, an Arabian author, "that any man in power, or holding a place under government, considered himself obliged to have a library of his own, and would spare no trouble or expense in collecting books, merely in order that people might say—'Such a one has a very fine library, or he possesses a unique copy of such a book, or has a copy of such a work in the handwriting of such a one.'" A great library was formed at Cordova by the caliph Al-hakem, who caused all sorts of rare and curious books to be bought by his agents in Cairo, Bagdad, Damascus, Alexandria, and other great cities of the East, and who was currently reported to have amassed a collection of not less than 400,000 volumes. The historian Ibnu-l-abbar, to increase the marvel, states that, "to give an idea of Al-hakem's immense erudition, it will only be necessary to record a well-ascertained fact—though strange to say neither Ibnu-l-faradhi, nor Ibn-Bashkuwal have mentioned it in their works—namely, that not one book was to be found in Al-hakem's library, whatever might be its contents, which the caliph had not perused, writing in the fly-leaf the name, surname, and patronymic of the author, that of the tribe or family to which he belonged, the year of his birth and death; after which followed such interesting anecdotes about the author or his work, as through his immense reading he had derived from other writers." Even those who have had no experience in cataloguing will agree that to do this for a collection of 40,000 volumes, not to say 400,000, would require no common share of industry. On the death of the caliph, in A.D. 796, the throne of Cordova was usurped by Al-mansur, who in order to conciliate the favour of the Mohammedant heologians, ordered all the books on philosophy and similar subjects to be destroyed, and they were accordingly either burned in the public squares or thrown into the wells and cisterns of the palace. Finally, on the overthrow of the dynasty of the Ommiades by rebel princes, Cordova was invaded and sacked, the palace of the caliphs was levelled with the ground, and the books of the splendid collection of Al-hakem taken as plunder, and sold in distant countries at the lowest prices.

While the number of books among the Arabs was so incredibly large, among the Christian nations the number was inconceivably small. The instinct of collecting and that of preserving libraries seem in some cases to have been equally deficient. Charlemagne was persuaded by his English librarian, Alcuin of York, to collect a library equal to that which Alcuin had seen in England; but in his will, the monarch expressly directed that it should be sold, and the proceeds given to the poor. The monastic libraries are usually spoken of as the great literary establishments of the middle ages, but the collections of monks and magnates are on the same scale of distressing poverty. The monastic library of Fulda, which Charlemagne had increased, if not founded, in A.D. 744, was celebrated during the whole middle ages, and in the year 1561 was found to contain 794 manuscripts. In the 12th century, the monastery of Monte Casino contained 90 volumes. The church of Ratisbon possessed in 1251, a library of 500 volumes; the library of the Sorbonne, in Paris, amounted in 1292 to 1000. The chronicler Geoffrey of Beaulieu relates that St. Louis, when on the Crusades, heard of a great sultan of the Saracens who made careful search for books of all kinds, and who had them transcribed at his own expense, and placed them in libraries for the use of the learned. St. Louis resolved, therefore, on his return to his own kingdom, to have copies made of all the books of the Holy Scriptures and general edification that he could find in the different abbeys, and he collected at the Holy Chapel, still existing at Paris, numerous works of St. Augustine, St. Ambrose, St. Jerome, and other authors. This library, like that of Charlemagne, was again dispersed at the king's death, and distributed among three religious orders. In 1373, as has already been mentioned, the library of the king of France consisted of only 910 volumes.

The revival of learning which preceded the invention of printing, had already begun to produce an alteration in this state of things, when that invention came to quicken and confirm it. The middle ages may be said to terminate with this discovery, in the middle of the 15th century.

So much has already been incidentally said of the continental libraries of modern times, that to enter on the subject in full would be to go over ground that has been already trodden. It will therefore be sufficient to treat of it here with comparative brevity. Italy was the first country to be conspicuous in this point of view. Italy is still rich in libraries of the second and third magnitude, but can boast of none that belongs to the first. It has been already mentioned that the Vatican, though rich in manuscripts, is now shown to contain not more than 100,000 printed books. There is a larger library in Rome itself, the Casanata, known by its admirable catalogue, made by the astronomer and bibliographer, Audiffredi, and said to contain 120,000 volumes of printed books and manuscripts. The collection, located at Naples since 1804, called the Biblioteca Borbonica or Bourbon library, and reputed to contain 200,000 printed volumes, is probably the largest library in Italy. The reputation of being one of the best belongs to the Brera library at Milan; a collection which, formed from the library of the suppressed order of Jesuits in 1772, was augmented by that of Count Firmian, the Austrian governor of Lombardy, a famous collection, in the published catalogue of which one volume is occupied with the English books. The numbers of the Brera were at one time greatly overstated; they have, upon counting, been reduced to about 100,000. The other great library of Milan, the Ambrosian, consisting of more than 100,000 printed books and 15,000 manuscripts, is that which attracted the attention of Europe in the early part of the 19th century, by the discoveries made in it by Angelo Mai, the librarian, of ancient palimpsests. The library was founded in the 17th century by the almost canonised Frederic Borromeo, the cousin of St. Charles of the same family, who left the singular injunction, that the manuscripts should not be published. At Bologna, the institution founded by Count Marsigli, the martial companion of Prince Eugene, counts among its 150,000 volumes a collection of Oriental manuscripts, brought by the count from the wars; and among its printed books a collection, scarcely less rare in Italy, of German poetry and literature, introduced by its librarian the great linguist Mezzofanti. Venice boasts in the library of St. Mark, a collection which was founded by Cardinal Bessarion, but of which Roncelli can only state by conjecture that it contains 100,000 volumes. It is subject to less doubt that it is one of the most magnificently lodged libraries in Europe, having been removed from the library buildings in the place of St. Mark, to the great hall in the Doge's palace. Florence is remarkable also for the magnificent building designed by Michael Angelo, in which is enshrined the Laurentian library, a collection of manuscripts so named from one of its founders, Lorenzo de' Medici. The great collection of printed books at Florence is called the Magliabecchian, from its founder, Magliabecchi, the celebrated "book-glutton," who was librarian to the Grand Duke, and who at his death in 1714, left his library to the public, and all his property for the purpose of enlarging and preserving it. His friend Manni, in 1731, added his own collection from respect for the memory of Magliabecchi; and in 1771, when the Grand Duke Leopold munificently gave up his own library for the public benefit, the printed books were sent to the Magliabecchian, and the manuscripts to the Laurentian. A few years ago Molini, the librarian, prepared to carry out in full the idea of bringing together in one collection all the printed books in Florence belonging to the public, and in another all the manuscripts; but the project, though commenced, seems to have stopped half way. One of the most interesting libraries in Italy is that of Ferrara, which though not of earlier date than 1747, contains 90,000 volumes, and among them the autographs of part of the 'Orlando Furioso,' of part of the 'Jerusalem Delivered,' and of Guarini's 'Pastor Fido.' Of the remaining libraries of Italy, that of Parma, remarkable for containing the Hebrew collection of De Rossi, was said by Roncelli, in 1846, to amount to 90,000 volumes; that of Piacenza, to more than 40,000; that of Lucca, to more than 50,000; that of Turin, to 120,000. Generally speaking the libraries of Italy appear to have been collected as much for display as use. They are usually confined to classical and modern Latin literature, and to that of Italy and France; and even within those limits to certain classes,—to books which have been always considered library books. To this of course there are exceptions; we have heard of an Icelandic library at Palermo; but they are rare. In his excellent history of Italian literature, Tiraboschi, himself the librarian of Modena, takes particular notice of the progress of libraries, century by century. An animated description of the Italian libraries is the principal feature in Valery's 'Voyage en Italie.' The rules of admission to these libraries are less liberal than those which prevail in France and Germany, and the number of days of closing is unusually large. There were in 1851, according to Mellado's Spanish Encyclopædia, published in that year, 29 public libraries in Spain, containing altogether about 627,200 volumes—a number for the whole country less than is accumulated in some single collections out of Spain. The three most interesting were, the national library at Madrid, containing, since it had received the contributions of the conventual libraries, about 200,000 volumes; the library of the Escurial, containing 24,000 volumes only of printed books and 4000 of manuscripts, chiefly Arabic; and the "Columbian" or cathedral library of Seville, remarkable for possessing some works which once belonged to Columbus. The libraries of Portugal have had no "golden age." In the report on the national library published in 1844, a list which is given of the foreign purchases of seven years occupies little more than four pages. The fate of one library in Portugal has been unique. In 1807, when the royal family emigrated to Brazil from the invasion of the French, the royal library sailed in the same fleet, and now forms the imperial library at Rio Janeiro. It was probably at the time of its arrival in Brazil the largest library in America.

France is in many respects a model to the rest of Europe with regard to libraries. It contains a collection of the first magnitude in the capital; it has several others of only less importance both in the capital and the provinces, and scattered over its surface it has many collections of different degrees of interest freely accessible. This description, which implies high praise, is not applicable in all its parts to any other country. The Royal Library of France dates its origin back to the 15th century, before the invention of printing, but it did not begin to be of real importance till the reign of Louis XIV. He is said to have found about 5000 volumes in it at the commencement of his long reign, and to have left 70,000. Under Louis XIV. the collection was not freely open to the public: the Italian minister of his minority, Cardinal Mazarin, was far more advanced than his French master in this respect. The first library of 40,000 volumes, which Mazarin collected with the assistance and advice of his librarian, Naudé, was treated, not as a private, but a public library. "From its door," says Naudé, in a dialogue he published, "shall resound that cry never yet heard in the republic of letters—'Come, all ye who desire to read, and freely enter in.'" It was this library which was sold by auction, in the course of the insurrection against Mazarin, by order of the Parliament of Paris, who directed that part of the proceeds should be offered as a reward to whoever should capture the Cardinal dead or alive. The minister, after his triumph and return to undisputed power, collected a second library, which he left to the public at his death, and which is now kept in the same building with the library of the Institute at Paris. It was probably the existence of this public collection which led to the opening of the royal one, which took place in 1737, some years after the grandson of Louis, seated on the throne of Spain, had already opened a public library at Madrid. It is difficult to trace with clearness the phases of publicity of the royal library which has often apparently been less public than its regulations would imply. The judicious liberality of the minister Colbert, the favour with which accessions to the library from the exertions of French ambassadors in foreign countries were looked upon, and a number of favourable circumstances, had gradually led, at the period of the Revolution, to the accumulation of a collection of books which, though it appears it was surpassed in mere numbers by that of Zaluski, was then the most valuable in Europe, and could only be rivalled in that respect by the imperial collection at Vienna. In foreign literature, however, its deficiencies were in many respects remarkable—in German and English especially. Great care had been bestowed, and justly, in amassing curious manuscripts from the furthest parts of Asia, and Fourmont boasted that, "for the literature of China, of Tartary, and of India, the king's library was then the richest library in Europe;" but it had no set—and it is doubtful if it has now—of the 'Gentleman's Magazine.' The history of the library during the Revolution is painfully interesting. Many of the librarians were involved in the calamities of that dreadful period. Barthelemy, the author of 'Anacharsis,' was sent to prison; three others, Carra, Girey-Dupré, and d'Ormesson, suffered by the guillotine; Champfort, the colleague of Carra, on being arrested in the library, endeavoured to commit suicide, and though not killed on the spot, died finally of the wounds inflicted. In the height of all this, the institution flourished, and the numerous acquisitions it made from the suppressed convents, raised it to the position it still occupies, of the first library in Europe. Amid the storm that raged around, one political fanatic, Henriot, proposed to burn the whole collection, and some courage and conduct were requisite to oppose and avert the execution of this and similar measures on a smaller scale, which were proposed as a tribute to the popular aversion to priestcraft and monarchy. At the same time proposals were occasionally brought forward which were singularly judicious. In 1795, Villar, deputy of La Mayenne, presented to the Convention a report, in which he pointed out, among other things, as indispensably necessary, the purchase of the books printed from year to year in France, and of those printed from year to year abroad, and laid great stress on the importance of seizing opportunities as they occurred, and of disregarding the suggestions of a false economy, which, he said, in such cases does but multiply difficulties and lead to vain regrets. The Napoleonic period was chiefly distinguished, in regard to the library, by its passion for enriching it by foreign conquest. These trophies had more or less completely to be restored when foreign conquerors were in their turn twice masters of Paris. After the Restoration the library quietly preserved its place at the head of European establishments, without much need to guard against rivalry, and the subject of little commentary but praise. During this time it was customary to speak of Van Praet, the librarian, as "the living catalogue," and it appeared to be quite unsuspected that there was need of any other. After 1830, complaints began to arise that so little had been done to reduce to order the chaotic mass that had been thrown into the library in the revolutionary times, and the more orderly accumulation since, that it was impossible to know what books were present in the library and what deficient, and an agitation gradually arose for a new and complete catalogue. Dr. Martin Lister, in the account of his journey to Paris, in 1698, published in 1699, said, with much simplicity, "They work daily and hard at the catalogue, which they intend to print. . . . . They purpose to put it into the press this year, and to finish it within a twelvemonth." They began to print in 1735, and have not finished in the 162 years that have elapsed since the visit of Dr. Lister. Ten folio volumes of the work, perhaps the handsomest volumes of a catalogue that have ever been printed, did but commence the labour, and all intention of completing that edition of the catalogue has now been abandoned for about a century. In 1855 came out the first volume of a new catalogue, commencing the division 'History of France,' and six volumes of that division have now appeared, and one volume of 'Medicine.' In regard to foreign languages, the errors in these volumes are far from unfrequent, and oversights of various descriptions may be pointed out. Still the existence of a printed catalogue of such extent on so interesting a subject is a boon, and if it proceeds as it has begun, all Europe will hail its success. In 1858 a commission, which was appointed by the French government to inquire into the affairs of the library, sent a commissioner to England in the person of M. Prosper Mérimée, the celebrated novelist and archæologist, who in a report made on his return, eulogised highly various of the arrangements introduced at the British Museum during Mr. Panizzi's administration, which he recommended for adoption in France. In the report of M. Rouland, the Minister of Public Instruction, to the Emperor of the French in 1860, the report of the commissioners is referred to as the recognised basis of the future administration of the library, and at the same time the Emperor's attention is called to the necessity of increased exertion to save the great establishment of France from the danger of being surpassed by its foreign rivals. The library may now be estimated to comprise about 880,000 volumes —the number given in a former part of this article (col. 206) being based on an erroneous assumption of the number of pamphlets, &c., as 735,000 instead of 750,000. M. Rouland proposes the measure of incorporating, in the vast collection of Paris, all the books that it does not already possess which are to be found in the other public libraries of the capital—a measure which he supports by the authority of the first Napoleon. That he confines this proposal to the libraries of Paris only, and excepts the departments, shows, however, that the minister anticipates opposition. No objection of any plausibility could be opposed to the plan of including such books in the catalogue—a plan which has already been carried into effect in Bajot's catalogue of the four libraries of the French marine, in which the books in all the four are given indiscriminately in one order of arrangement, with an indication of the collections in which they exist, sometimes in one only and sometimes in all the four.

In addition to its great collection, Paris boasts of several other libraries of large extent. The Mazarine library has 132,000 volumes, that of St. Geneviève was officially returned in 1849 as of 180,000 printed volumes and 3500 manuscripts; that of the Arsenal is said to contain more than 202,000 printed volumes, and 6000 manuscripts. The library of the Arsenal is a special one, and said to be the richest in Europe in works of fiction and amusement. There are also a City library and some minor collections.

The provincial libraries of France are scattered thickly over the country, and many of them are on a level in point of numbers and value with the secondary libraries of Paris. That of Lyons is said to contain about 120,000 volumes of printed books; that of Rouen in 1855, was of 110,000; that of Bordeaux in the same year, 123,000; of Besancon 80,000; of Strasburg 180,000. Many of these institutions have been largely augmented of late years, and they vary in composition and character. The strength of the library of Rouen consists in modern literature, and of the arts and sciences; that of Strasburg is remarkable for its abundance of periodical publications. Many of the smaller libraries are interesting from their history and historical associations; and they often show signs of diligence and sagacity in the choice, arrangement, and management of the collections. One of the points of contrast which produces the most forcible impression on an English visitor of Boulogne from Dover or Folkestone, is the striking superiority in regard to opportunities for self-cultivation and improvement enjoyed by the residents in French provincial towns.

In Germany, the land of universities, the number of eminent libraries is, as might be expected, large. Five great collections of special interest are at present in existence there—the Imperial Library at Vienna, the Royal Libraries at Munich, Dresden, and Berlin, and the University Library at Göttingen. The library of Vienna, founded, it is said about 1440, consisted in 1660, when Lambecius was appointed librarian, of about 80,000 volumes, and a Latin inscription to that effect was placed over the door, with a declaration, that the collection yielded to no library on earth in the number and value of its books and in the variety of languages it contained. Augmented by the addition of the collections of several of its librarians—Blotz, Tengnagel, Lambecius—as they successively deceased, it also acquired at his death the 15,000 volumes of Prince Eugene. The magnificent building which was afterwards erected for it by the architect Fischer of Erlach, continued for many years the finest library-room in Europe. Denis, who published in 1775 his excellent 'Introduction to Bibliography,' was unhappily tempted, in a moment of weakness, to assert that the library then contained about 300,000 volumes; and, when in 1796 he had himself become chief librarian, he repeated the assertion with the authority which his position gave him. Balbi, in his 'Essay on the Library of Vienna,' published sixty years afterwards, demonstrated with sufficient certainty, that even in 1789 the number could not have been more than 196,000, but he maintained that the statement of 300,000 which was formerly erroneous had now in the lapse of years become correct, while the analysation of his own statement showed, on the contrary, that the proper cypher was far below it. There can be little doubt that now, in 1860, that number has at length been really attained and passed, but the exact amount of what the library contains is still uncertain. Petzholdt, in 1853, stated it at 385,000. The liberality of the imperial court has not been extended largely in the establishment. When Mosel published his history of the library in 1835, he stated that the number of visitors to the reading-room having increased beyond what the room would conveniently hold, the remedy had been resorted to of not allowing more than a certain number to enter, and no new reading-room appears to have been erected since. The space for the placing of books is so limited, that in the magnificent architectural saloon, rows of volumes are said in some cases to stand four deep. The library of Vienna is, in its composition, a fine specimen of a great palatial library, mainly formed by the gradual accumulation of centuries.

The library of Munich, originally founded in the period between 1550 and 1579, was for more than two hundred years a collection of no note: the number of volumes in 1795 being known to be not more than 11,000. In 1803 a totally new era for the library begun, by the dissolution of many of the great monasteries of Bavaria, the libraries of which were transferred to the royal collection. These libraries, being situated for the most part in or near the country where the earliest productions of printing were issued, and having been in a flourishing state at the period, were remarkably rich in early specimens of the art; and the consequence of bringing them together was the formation of an unequalled collection of these "cradle-books," or "incunabula," and also of a great assemblage of duplicates. The kings of Bavaria, taking a pride in the immense stores of learning of which they had become masters, added liberally by purchase to the collection, which would otherwise have been singularly one-sided, and in 1843 a new building was added to the other remarkable edifices of Munich, in which the ground-floor was occupied by the archives of the kingdom, and the first-floor by the great library. One feature of the construction does much credit to the architect, Gaertner, and demands especial notice. There is no book throughout the building which cannot be readily reached by the hand, without the necessity of using steps or ladders, a necessity fraught with accident, which, as imposed in many libraries, has caused the death of several librarians, and is likely to cause the death of more. The numbers of the library of Munich have been a question for years—the reasons have been already given for which 440,000 volumes may be assumed as the nearest approximation. The library at Dresden, begun in 1556 by the then elector of Saxony, first rose into importance after the year 1760. The Counts Bünau and Brühl, of Dresden, were long rival book-collectors—Bünau forming an excellent collection on the German plan, studiously and economically assembling from all quarters the books that threw most light on literature, history, and science; his rival, Count Brühl, the frivolous favourite of Augustus III., elector of Saxony and king of Poland, giving a high price for choice copies and rare editions, such as are more prized in general in the libraries of Italy than of Germany. Within four years the death of these magnates placed both their libraries on sale, and both were bought by the king, who thus formed a library at once of intrinsic and bibliographical value. The Bünau collection was of more than 42,000 volumes, and the Brühl of 62,000; and the former is still well-known to scholars by its excellent though unfinished classified printed catalogue, made by the librarian, Francke. The library at Dresden, which is located in the magnificent Japanese palace, continued for some time to receive liberal augmentations, but has been of late years insufficiently supplied with funds. A volume upon it was published by the late librarian, Falkenstein, of a kind such as it would be desirable to have for every library,—a description of a walk through the rooms, with a brief but lucid statement of what are the treasures in every department. The number of volumes is now stated at over 300,000.

The royal library of Berlin is the modern representative of the electoral library, founded in 1650. It has had the honour of receiving the attention of Frederick the Great, the account of whose proceedings with it is a record of weak caprice which may tax even the admiration of Mr. Carlyle. Its augmentations have been more gradual than those of Munich and Dresden, and its progress has been accelerated instead of diminished during late years, under the administration of Dr. Pertz. A collection of Sanscrit manuscripts, a collection of Aldines, and above all a collection of German literature—the Meusebach library of 36,000 volumes, have much increased its value. The number of volumes is now stated at over 500,000.

The university library at Göttingen is remarkable for the novelty of the grounds upon which it attained its celebrity. Founded with the university itself, in 1734, it already contained from 50,000 to 60,000 volumes, when Heyne went to Göttingen, in 1763, and from that period it began to manifest the effects of the industry and learning which as its librarian he began to devote to it. With a liberal but not profuse expenditure, judiciously directed, he produced, in the course of a few years, a library in which every kind of research, literary or scientific, might be pursued with a success beyond that attainable in other libraries, because this collection had been brought together by system and most other collections by chance. Whenever the university of Göttingen was mentioned, the library was sure to be mentioned with it. It was the silent and permanent Professor which drew the most students to Göttingen. Its arrangements with regard to cataloguing and otherwise were cited as all but perfect, and a diligence was expended upon them which certainly claimed admiration, even if in some cases carried to excess. Of late years its fame is not quite so bright as formerly. Statements have varied as to its numbers: an official return made to the English Foreign Office in 1850 gives the number of volumes as about 350,000, counting as a volume whatever comes as such from the hands of the binder, whether containing a pamphlet of a few pages or fifty such pamphlets.

There is also an important library at Stuttgard, belonging to the King of Wirtemberg, and stated to contain in 1860 upwards of 200,000 volumes, including the largest collection of Bibles in the world: and an interesting library at Wolfenbüttel, formed by the Dukes of Brunswick, one of whom, in the latter part of the 17th century, found his chief pleasure in writing the catalogue. Every part of Germany abounds with libraries, of interest from their antiquity or their curiosity, of all of which some mention will be found in Dr. Julius Petzholdt's often reprinted 'Handbuch der Deutschen Bibliotheken,' in which he also gives lists of the books written respecting them, their catalogues, &c. The libraries of Germany, compared with others in the principal countries of Europe, have been remarkable for their comprehensive character. When the Italian libraries chiefly consisted of Italian books, the Spanish libraries of Italian and Spanish, the French of Italian, Spanish, and French, the English of Italian, Spanish, French, and English, all with the addition of the classics,—the German consisted of all these languages, with the addition of German. It is in German libraries also that are most frequently to be found the leading volumes of the secondary languages of Europe, but they are not remarkably rich in this point of view. There is no large collection of Russian, apparently, in any German library, with the exception of that of Göttingen, in which one was commenced but not adequately continued.

The other countries of continental Europe must be passed over on the present occasion with very brief notice. The libraries of Belgium are mostly of recent formation, a great destruction among the old collections having taken place at the time of the French Revolution. Voisin, the historian of the Belgian libraries, states that the Jesuit libraries alone numbered more than 800,000 volumes in Belgium at the time of the dissolution of the order, and that in 1840 the whole number of books in the public libraries was less, amounting altogether to little more than 700,000. A royal library was first founded at Brussels in 1836, by the purchase of the collection of 60,000 volumes belonging to Van Hulthem of Ghent, an amateur who had formed an unequalled collection of books on Belgium, and the sale of whose library presented an opportunity which the government wisely determined not to let escape.

In Holland, the library at the Hague is larger than that of Amsterdam; but the Dutch collections in general are of less extent and importance than might have been expected. Denmark is remarkable among the smaller countries of Europe for the spirit and sagacity which it has displayed on the subject of libraries. The royal library of Copenhagen far surpasses every other collection in Scandinavia in numbers and interest. It is chiefly formed, like the Dresden collection, of the amalgamation of two private libraries—those of Count Thott, an eminent collector, and of Suhm, the most popular historian of Denmark. The collection of Thott was not acquired entire, but at the sale of his library of 120,000 volumes, the largest private collection ever formed in Denmark, the royal library, to which some of his choicest works had been previously bequeathed, bought to the extent of 61,547 volumes, at an amazingly low price. This was about 1792; and nearly at the same time an agreement was formed with Suhm, who was old and childless, that after his death his collection should be added to the royal collection, in consideration of a moderate annuity, which by his death fell in in two years. This added another 100,000 volumes to the library, and placed it in that high position which it has since maintained. According to the 'Nordisk Conversations-Lexikon,' published at Copenhagen in 1858, it then contained about 450,000 volumes of printed books and 20,000 of manuscripts. The university library in Copenhagen contained at the same time about 200,000 volumes; and there was a third library in the same city, founded by the will of General Classen in 1796, and much used, since the measure had been adopted of confining it to one subject only, that of natural history. Sweden is very inferior in the matter of libraries to Denmark: the principal library is that of the university of Upsal, which is said in the 'Stockholm Conversations-Lexikon' for 1857 to contain 130,000 volumes of printed books and about 7000 manuscripts. The royal library of Stockholm only dates back to the time of Charles X. of Sweden, as his predecessor, Queen Christina, when she left the country on her abdication, took the then royal library with her, and it is now in the Vatican at Rome. The Stockholm library amounted in 1857 to 100,000 volumes of printed books and between 4000 and 5000 manuscripts, and is now (1860) about to be removed from the royal palace, where it has outgrown its apartments, to a new building which has been erected for it from the designs of a German architect.

The great Polish library of Zaluski has been already spoken of on more than one occasion. Its collector is one of the most remarkable men in the annals of libraries. His incessant devotion to that great object—the collection of a public library, which he opened during his lifetime, and in which he himself took his seat in the reading-room as one of the readers—inspires us with respect, and makes us regret that, according to the Polish historian Lelewel, his method of obtaining books was often seriously objectionable. "Some he bought," says Lelewel, "some he acquired by exchange, some he extorted, and some he obtained surreptitiously." The result of his long and patriotic labours was, that his great Polish library, with not more than five Russian books in it, was carried off to St. Petersburg. The best that can be said in extenuation of the act is, that in Poland itself the treatment of libraries was anything but exemplary. Lelewel relates that in the Jagellon library of the university of Cracow, during the Austrian occupation, about 1800, the sparrows built their nests in the piles of volumes, and that the librarian Przybylski called them his best assistant librarians, because they ate the insects. The principal present libraries on the Polish soil are, that of Lemberg, founded by Count Ossolinski, formerly director of the imperial library of Vienna; that of Posen, founded by Count Raczynski at his private expense for public use; and that of Cracow. Among Russian libraries, the imperial of St. Petersburg stands of course pre-eminent, and now enjoys the full sunshine of imperial favour. In the year 1852 the Emperor Nicolas bought for it in a mass the library of the academician Pogodin, for which the sum of 150,000 silver rubles, or 24,000*l.*, was given. The library having outgrown the building, a large extension of it has been ordered, and the works are in progress. Of the other libraries at St. Petersburg, that of the Academy of Sciences, and of the Rumiantsov Museum, founded by Count Rumiantsov, are the most important, the former containing a splendid collection of Oriental manuscripts, partly acquired by the successes of the Russian arms in Persia. Though Moscow possesses two libraries, one of the synod and another of the university, the deficiency of a public library is so much felt, that in 1859 the intention of founding one by subscription was under discussion. The libraries of Kazan, Kiev, and Kharkov are some of the most important of the provincial libraries, and a general activity respecting libraries now prevails in Russia, of which in a few years it may be expected to see the fruits.

England has been a country whose condition with regard to libraries was decidedly in arrear of its general condition with regard to learning and literature. For centuries its capital was without a public library; many of its towns and cities of a size and importance which would on the Continent ensure their possessing such an institution, are still without one. While in some localities libraries were so distressingly deficient, in others they were uselessly numerous. With no collection of books beyond subscription libraries of moderate extent at Newcastle or Liverpool, twenty or thirty were congregated at Oxford and Cambridge, where however they were never "introduced to each other," and drew no advantage from the proximity. One great objection existed to almost all the libraries of England—their inaccessibility in some cases, their too limited accessibility in general. A movement has now commenced in two directions: to collect in one locality a great monumental library, such as may give to our authors and investigators advantages they have never enjoyed, but which for the advancement of sound literature are really indispensable; and to scatter all over the country collections of respectability and value, so as to provide for residents in all parts reasonable access to sources of solid instruction. It is a great thing that so much should have been done in England without these appliances.

A separate article has been given in the English Cyclopædia to the British Museum. No other collection in the metropolis is of so much importance as some in the provinces. The library of the London Institution in Finsbury Circus is an establishment at the head of a class, once promising to become more numerous than it ever became—the proprietary libraries, set on foot by a union of shareholders, who, in addition to the purchase of the share, contribute an annual subscription, which defrays the going-on expenses of the establishment. An enthusiasm for these valuable institutions was a pleasing feature at the commencement of the century; the Royal Institution, the London, the Russell, and the Surrey were established within a few years of each other, beginning with 1803. The library of the London Institution was formed with admirable taste and judgment by extensive purchases at the sales of the Marquis of Lansdowne and others in 1806 and subsequent years. As Professor Porson was the librarian, it may be supposed that German was not in the ascendant, but in other modern literatures—French, Spanish, Italian—the collection is much richer than usual. By a liberal regulation, each shareholder or proprietor is entitled to give admission to two readers; and the noble library-room of the London Institution, close to the city of London, but looking out on the trees and turf of the Circus, has been the scene in which the literary tastes and feelings of many a young fellow-citizen of Milton have been imbibed or strengthened. The library contains 60,000 volumes; but less money is annually expended on the books than on the lectures, which are one of the principal attractions in this as in most similar establishments. In the Royal Institution, founded before the London, in 1803, science has always been the most prominent feature; and from its Laboratory the discoveries of Davy and Faraday have emanated, to spread through Europe. The library is reported to contain about 26,000 volumes. The Russell Institution is an establishment of the same kind, but of less importance. Two others of the class, the Surrey and the Aldersgate Street Institutions, have, after some years of prosperity, sunk and disappeared, a lamentable proof that without permanent endowment such institutions are liable to dissolution as well as decay. Persons have been known to purchase shares in an association of this kind with the express purpose of proposing to break up the institution and divide the property, reckless of the detriment they might inflict on the literary prospects of coming generations. In cases where the original spirit survived in the body of the members, such proposals have been rejected with the indignation they deserve.

Many associations of this kind exist in the suburbs of London, at Islington and elsewhere; and the Mechanics' Institutions, which were originally founded at Glasgow, but introduced to London in 1823, may be regarded as a humbler form of the same kind of establishment. The "London Library," in St. James's Square, has a somewhat different character. The London Library is, in fact, a proprietary circulating library, while the London Institution and others of its class are proprietary reading-rooms. The libraries of the Clubs—another series of proprietary libraries—are in appearance some of the most splendid rooms in London, and are in some cases remarkable for the intrinsic value as well as for the fine condition of their volumes. The library of the Athenæum contains, for instance, a good collection of English history.

The libraries of the learned societies, and of the inns of court, are in many instances of considerable importance, and in some not exclusively of a professional or limited character. That of the Royal Society, lately removed to Burlington House, stands at the head, with 50,000 volumes. The Antiquarian, the Geographical, the Royal Asiatic, and the Linnæan societies have collections which comprise many valuable works, but which, in some cases, are almost wholly made up of donations or exchanges, and it would be vain under those circumstances to expect completeness. The libraries of the inns of court are differently situated, and more than one of them has lately been the object of liberal expenditure. The library of Lincoln's Inn, is the oldest in London, its foundation dating from 1497, but the noble edifice in which it stands was only erected in 1845, on what was formerly a portion of the gardens. It has been made the repository of a greatly extended collection of books, not only of English, but of American, colonial, and foreign law, amounting, when Mr. Spilsbury the librarian published an account of it in 1856, to 27,000 printed books and 700 manuscripts. A new building is now erecting for the library of the Middle Temple, rendered necessary by the recent enlargement of the collection. There are two libraries in London chiefly intended for the clerical profession, but of a more public character than most of those which have been enumerated. The library of Sion College, in London Wall, of which all the incumbents of benefices in the city of London are fellows, was founded as far back as 1630, when, on the Rev. John White building a row of almshouses on the usual one-story plan, it struck one of his friends that the space above them, otherwise thrown away, would afford an excellent opportunity for building a library, without any expense for ground, and the notion was carried out. The collection is said to amount to 40,000 volumes, and admission can be granted by any Fellow of the college or by the librarian. The Dissenters' library, in Redcross Street, founded by Dr. Williams, is of about half the number of volumes and of still more easy access.

The "administrative" libraries of London are not prominent. The libraries of the Houses of Lords and Commons, both in the new Houses of Parliament, but entirely distinct, are of recent formation; the former libraries having been destroyed at the conflagration of 1834. The library of the East India House has been already spoken of. It is the most important collection of the kind in London.

Of libraries not in the capital, the Bodleian of Oxford is the most extensive and the most interesting. Long the first collection in England, it still remains the second and is likely long to remain so. Increased interest in its prosperity has been manifested in the present century, during which it has received the valuable presents of the Gough, the Malone, and the Douce collections, each of them more important than any single donation in the 18th century, and only to be paralleled by the benefactions of the Lauds and Seldens of the 17th. Its venerable buildings, so appropriate to a university library, are now becoming inadequate to the reception of its treasures, and a proposal has been recently decided on which will at once provide the establishment with room and increase its magnificence. The Radcliffe Library building, in almost immediate juxtaposition to the Bodleian Library, and remarkable for the beauty of its interior as well as exterior structure, is to be added as a reading-room to the Bodleian, with which it will be connected by a passage, and the Radcliffe collection is to be removed elsewhere. This will be singularly in accordance with the intentions of the founder, Dr. Radcliffe, the great physician, who originally intended to enlarge the Bodleian Library, by building another room connected with it; a scheme which only failed on account of some conditions insisted on by Exeter College. The Radcliffe and the Bodleian Libraries have been remarkable among libraries in close juxtaposition for having come to an agreement which would have been thought likely to suggest itself to almost all libraries in a similar predicament. The Radcliffe has confined itself to the purchase of books in a particular department—natural history—and the Bodleian has avoided making purchases in that department. Had a similar plan been followed with regard to college libraries, and Hebrew or Arabic manuscripts, for instance, been as systematically collected at one, as Welsh manuscripts have accidentally been at another,—at Jesus College—the large assemblages of books at Oxford might have constituted one all-embracing library. The Bodleian library consisted, in 1849, of 220,000 volumes as returned to the House of Commons, and may be now estimated to amount to 250,000. There are several minor libraries belonging to the University—the Radcliffe, the Ashmolean, the library of the Taylor Institution for modern languages, &c. The college libraries are, however, the distinguishing glory of Oxford. Within a short walk of each other, in a city of not more than 30,000 inhabitants are found a range of some of the most splendid edifices ever erected for the reception of literature, most of them enclosed with lawns and gardens, some venerable for antiquity, some radiant with architectural splendour. Christ Church and All Souls are particularly magnificent, Merton is venerable; but almost all have striking attractions, and each of many would be a gem elsewhere. The same may be said of Cambridge, where, indeed, the arrangement of the buildings is superior to that at Oxford, and one range of gardens with noble trees joins on to another, leading along the banks of the Cam, from college to college, from library to library. By perhaps an intentional arrangement of Sir Christopher Wren, who built the noble library at Trinity College, Cambridge—the place of education of Bacon, Newton, and Byron, of Tennyson, Thackeray, and Macaulay—the windows are so high that the view of this unrivalled scholastic landscape which they command is not allowed to distract the reader from study. The library so lodged, which now contains about 50,000 volumes, embraces the autograph of Milton's Comus, the Shakespere collection of Capel, and the German library of Archdeacon Hare. The library of St. John's is, like the college, a rival to Trinity; Bennet's is famous for its Anglo-Saxon manuscripts; that of Magdalen for the autograph of Pepys's Diary and the Pepys collection of ballads. Other libraries have other claims to attention, while the University Library, placed in the new and splendid room, erected by Mr. Cockerel, which is only a portion of the intended design, forms a worthier rival than is supposed to the Bodleian. The collection of about 30,000 volumes, brought together by Bishop Moore of Norwich, and presented to the University by George I., abounds in resources not yet sufficiently explored. The library is spoken of in the University Calendar as containing over 170,000 volumes. The Fitzwilliam library also belonging to the University, and placed in the Fitzwilliam Museum, of which it forms a part, is rich in works of art.

Manchester was long distinguished among English towns—as it is now among English cities—by its possession of a library to which access was as free as to any of the libraries of the continent. It was founded in 1653 by the will of Humphrey Chetham, of Manchester, whose family motto was not of a very liberal cast, "Quod tuum tene," "Keep what is thine." There can hardly be a more striking contrast than that between the low narrow and crowded rooms in the building of Chetham's hospital, where this collection, chiefly of ancient folios, is now, it is true, accessible to the student, but seldom disturbed, and the fine airy lofty rooms, full of modern books in splendid bindings, which house the "Free Library" of Manchester, founded in 1850, within an easy walk of it. The Manchester library was the first established under the Free Library Act of 1850, which gave power for limited local rates to be levied for the establishment of a free and public library, on the consent obtained of two-thirds of a meeting of the rate-payers. The Americans had already anticipated us by a similar law, but the English Libraries Act may be considered as only an extension of the Museums Act of 1845. The early history of the Manchester library is set forth in the reports of Mr. Edward Edwards, its first librarian, whose exertions are understood to have had a considerable share in promoting and obtaining the Act of Parliament. Free libraries have since been proposed and adopted in many localities, and rejected in others—one has been rejected in London, and one has been founded in Oxford, adding to that city of libraries one collection more. At Liverpool a great example of munificence has been set by Mr. Brown, a Liverpool merchant, trading with America. The Free Library, founded in 1852, having grown so rapidly as to require an extension of room, he presented the town with a new and spacious library building at his own expense, of which the estimated cost was 25,000*l*. A connection has been proposed to be established in some cases between old establishments and the new—such as the Chetham and the Free—and this would certainly be one way of revivifying the old cathedral libraries, of which Mr. Beriah Botfield's volume on that subject has shown that they possess more valuable collections than they have always had credit for.

In Scotland, the largest collection is the Advocates' Library, at Edinburgh, belonging to the Faculty of Advocates, and located close to the Courts of Law, in immediate proximity to, and under the same roof with, the library of the Writers to the Signet. The Advocates' Library formerly occupied the identical room now occupied by that of the Writers, and some passages of law have, it is understood, taken place between the two branches of the profession respecting their rights to light, which is so deficient, that in some underground rooms of the Advocates' Library candles are used at noon-day. The present Signet library is a palatial room, which reminds the visitor by its appearance of the libraries of the London clubs. The Advocates and the Signet libraries together—the former about 180,000 volumes, and the latter about 50,000—amount to nearly a quarter of a million volumes, and if an arrangement had been come to similar to that between the Bodleian and Radcliffe libraries, Edinburgh might have reaped a material benefit. The Advocates' library contains a large Spanish collection, formerly belonging to the Marquis of Astorga, and acquired in a mass from Mr. Thorpe, the London bookseller, but found, after purchase, to be much less choice than was expected. It has also a collection of works relating to the Scandinavian nations, bought like a similar one in the British Museum of Professor Thorkelin, and a mass of 100,000 foreign dissertations bought at the recommendation of Sir William Hamilton for 80*l*. Though both the Advocates and the Signet library are rich in law, yet neither is by any means exclusively a professional library, and neither is pre-eminently Scottish, though of course, Scottish publications predominate more than elsewhere. The library of the University of Edinburgh occupies the finest room in Scotland and one of the finest in Great Britain. The collection has upwards of 100,000 volumes, but is said to be very deficient in some branches of learning. The leading collections in provincial Scotland are those of the universities—Glasgow, St. Andrews, and Aberdeen. They were long an object of odium to English booksellers, on account of the privilege that had been somewhat liberally granted to them of demanding a copy of every book published. This right was exercised in very unequal degrees, for when it was abolished in 1835, and compensation granted in proportion to the actual loss sustained, Aberdeen was ordered to receive only 320*l*. a-year from the Consolidated Fund, while Glasgow was rewarded for its diligence with 707*l*. Glasgow, in addition to its fine university library, has that of the Hunterian Museum, founded by Dr. Hunter, of London.

There is probably no more singular origin of a library on record than that of Trinity College library in Dublin. The English army, which had defeated some Irish insurgents and their Spanish allies at the battle of Kinsale, on Christmas Eve, 1601, resolved to "do some worthy act that might be a memorial of the due respect they had for true religion and learning." For this purpose, the soldiers raised among themselves 1800*l*. to furnish a library for the University of Dublin, then recently founded. Their agents coming to London for that purpose, found Sir Thomas Bodley engaged in making purchases for his intended library at Oxford, and conferred with him on the choice of books. In 1656, the death of Archbishop Ussher brought his valuable library into the market, and again "the soldiers and officers of the then army in Ireland, out of emulation to the former noble action of Queen Elizabeth's army, were incited by some men of public spirit to the like performance," and the archbishop's library was bought by the army and presented to Trinity College, with the sanction of Oliver Cromwell. The most important addition ever made to it at one time, was that of the Fagel collection, formed by several generations of the Fagel family in Holland, and amounting to nearly 18,000 volumes, which were acquired for 10,000*l*. Some valuable books were bequeathed by a Mr. Quin, but under such onerous conditions that Mr. Panizzi, who had to cross the sea for the purpose of examining an Ariosto of the collection for his edition of the 'Orlando,' complains loudly of the illiberal restrictions by which the donor had rendered it impossible to receive his benefits with unmixed feelings of gratitude. The Trinity College collection was counted in 1848, and found then to contain 101,962 volumes of printed books, and 1512 of manuscripts. Marsh's library, of about 5000 volumes, founded at Dublin in 1707, by Archbishop Narcissus

Marsh, who died in 1718, is said to be the most easily accessible of any in Ireland, but the applicant for admission is required to produce a voucher of his respectability. An Act of Parliament was passed in 1854 authorising its transfer to a new building to be erected in Dublin as a National Gallery and Museum. The libraries of the Royal Hibernian Academy, the Dublin Society, and the King's Inns, or Inns of Court, are the most prominent remaining collections of the Irish capital. The library of St. Patrick's College, Maynooth, is rising into importance, and those of the new Queen's Colleges in various parts of Ireland will in some cases form new literary centres of extensive districts.

Of the libraries of America, in general, Mr. Rhees' 'Manual of Public Libraries,' amid a large quantity of uninteresting particulars of insignificant institutions, contains some striking statistics. There are now, it appears, twenty-five libraries in the United States which contain each more than 20,000 volumes, the whole number in the twenty-five being 979,902, or little short of a million. The State of New York contains six of these; the State of Massachusetts five; and there are also five in the district of Columbia, or Washington and the country immediately adjoining. In the libraries of the United States the proportion of foreign books is in general small. Of all the libraries from which reports have been received by Mr. Rhees, the one that has the largest collection in French has 4000 volumes; the largest collection in German 6000; and the largest in Spanish, which is in California, 596. It is probable, however, from this statement, that Mr. Rhees has received no report from some of the principal libraries of the great cities. The history of some of these presents many points of interest. The library at Harvard College, at Cambridge, near Boston, which was for more than two hundred years the largest and most valuable in the United States, was founded in 1638, and received the benefactions of some of the early contributors to the Bodleian, Sir Kenelm Digby included. It had increased to 6000 volumes, of which a catalogue had been published, when it was totally destroyed by a fire in 1764. The legislature of Massachusetts was then in session at Harvard Hall, and voted immediately 2000*l.* to erect a new building. Subscriptions soon flowed in to reinstate the library, and Thomas Hollis, of London, signalised himself by his liberality, which was continued by members of his family till the donations amounted to 6000*l.*, currency of Massachusetts. Among the English donors to the collection occurs the name of Mr. Thomas Grenville, who gave 100*l.* in 1846. The only fixed income of the library to this day, is what is called the Hollis and Shapleigh Fund, amounting to about 450 dollars a year, but the deficiency is made up by munificent though irregular donations. The library counted in 1858, when Mr. Guild's 'Librarian's Manual' was published, 75,000 volumes in the main library, placed in a building called Gore Hall. If other collections were included, such as the University Medical Library of 2000 volumes, kept some miles off at the Medical College in Boston, the total would amount to 116,000, and if the society libraries of the students were added, the whole would be 128,000. The libraries of Yale College, at Newhaven in Connecticut, and of Brown University, at Providence in Rhode Island, number respectively 35,000 and 23,000 volumes. The collection of the Library Company at Philadelphia, is especially interesting as being that into which the few books have grown which were originally brought together in 1731, by a few youths, chiefly artificers, at the suggestion of Benjamin Franklin. It occupies in 1860 a separate building, erected so long ago as 1789, and of which Mr. Guild remarks, "the style of architecture is of course somewhat antique." The edifice is adorned, over the principal door, with a statue of Franklin, executed in Italy by Lazzarini, and the first specimen of sculpture, of life size, ever imported into the United States. It contains 60,000 volumes, and with it is kept under the same roof the collection of Mr. Logan, Franklin's early patron, amounting to 10,000 volumes more. Washington, as the official capital of the United States, is the place at which some of its most important libraries are assembled. The library of Congress has been twice destroyed by fire, once by the British army in 1814, as an act of vengeance for the destruction by the Americans of the House of Assembly of Upper Canada; and the second time by accident on the 24th of December, 1851. Fortunately on the former occasion only 3000 volumes perished, in the latter but 20,000 volumes were saved out of 55,000. The library has in consequence been rebuilt entirely of iron, —floor, roof, pillars, staircases, and shelves. The collection was estimated in 1858 to amount to 63,000 volumes. Of the State libraries of America, that of New York, kept at Albany, and amounting in 1858 to 52,000 volumes, is the most extensive. The Astor Library, already mentioned, was opened at New York in 1854, with 70,000 volumes, chiefly collected by Dr. Cogswell, the librarian, in three visits to Europe in preceding years; and in 1855, Mr. William Astor, the son of the founder, declared his intention of building, at his own expense, another gallery by the side of the former, to contain an additional 100,000 volumes. The Boston Athenæum, a proprietary library, which had been founded in 1806, on the plan, it was said, of the London Institution, had, in 1858, attained to a position surpassing that of its prototype, if the number of books be correctly stated at 70,000. This was the leading library of Boston till the legislature of Massachusetts authorised the levying of rates for the formation of an entirely free library. Mr. Bates, a native of Boston, but carrying on business as a merchant in London, wrote in 1852 to offer a donation of 50,000 dollars towards the purchase of books; and in 1855, as soon as he received information that the building was actually commenced, he sent a donation of another 50,000 dollars for the same purpose. Other citizens contributed collections of books, some of 10,000 dollars, &c.; and on the 1st of January, 1858, the new building was opened with appropriate ceremonies, and Boston found itself in possession of a public library of 65,000 volumes. An American banker in London, Mr. George Peabody, is the founder of two institutions in the United States comprising public libraries. 'The Peabody Institute' of Danvers, and 'the Peabody Institute' of Baltimore. The principal defect of the present great movement in America, is the want of concentration. It is evident from the spirit that has shown itself among its merchant princes, that it will soon be in possession of several libraries of the third, and probably of some of the second, order; but there is as yet no indication of its being speedily endowed with one of the first, a great central collection. Amid the difficulties presented by the rivalry of different states, the most feasible plan of effecting this great object, an object more important to the scholarship and intellectual progress of the country, than the foundation of an additional twenty thousand common school libraries, appeared to be that advocated by Professor Jewett, of applying to the formation of such a library part of the funds of the Smithsonian Institute, founded by Congress at Washington from the bequest of Mr. Smithson, an Englishman. The scheme was sanctioned by Congress, but its actual execution seems to have depended on the personal influence of the Professor, and it was at once abandoned when by the proceedings of another Professor he was compelled to resign. The Smithsonian library, now a collection of about 25,000 volumes, has forfeited, at the request of its own officers, the right of receiving a copy of all books published in America; and is for the future to be confined almost entirely to works of science. In America, as in Europe, the failure or success of projects of great public importance seems to be often viewed with indifference by the great body of the public, and to depend almost entirely on the presence or absence of particular individuals of some force of character.

In Upper Canada a system with regard to public libraries has been introduced analogous to that prevailing in England with regard to national schools. If a fund be raised by a corporation for the foundation of a library, it may apply to the council of public instruction, and select books from a list sanctioned by the council, to the value of the money raised. The council in return sends back not only these books, but a number of other volumes of equal money value selected by the council itself. This system, which is that of the Rev. Egerton Ryerson, is considered by many Americans superior to that which prevails in the United States. Three hundred and twenty-six libraries in Upper Canada have been founded on this plan, in connection with schools and otherwise. The largest libraries in the country are one of about 6000 volumes at Hamilton, and one of 7000 at the University of Toronto. The library of the Legislature, at present at Toronto, is an excellent collection, of which a good catalogue has been published. The collections in Lower Canada are of a different cast, the most important being those of the old Jesuit colleges. The largest library in the British Colonies is probably the Public Library of the Cape of Good Hope, at Cape Town, of more than 30,000 volumes.

In Australia, the new library at Melbourne, which already contains 25,000 volumes, is conspicuous also for the number of its readers, which in last year amounted to 77,000, more than half the number of those in the same period at the British Museum. These facts in the recent history of libraries in the colonies and offspring of England, are remarkable in a high degree, and there is quite enough to justify the inference we have drawn that a new era in the history of libraries is approaching.

A brief notice of the best sources of information on the subject will conclude this article. On the history of individual libraries, a whole library has been written. The mere titles of books on the subject, with references to notices in other books, fill up five hundred and forty octavo pages in Vogel's 'Literatur öffentlicher Bibliotheken,' a valuable compilation, which is intended as a guide to all the printed information in existence on the public and corporation libraries in Europe, and also on the private libraries, no small number, which have subsequently become a portion of public ones. The volume was published in Leipzig in 1840, and in the same year Dr. Petzholdt commenced the issue of his bibliographical periodical 'Anzeiger für Literatur der Bibliothekwissenschaft,' which in addition to the titles, contains short critical notices of catalogues, reports, and other books relating to libraries. It is compiled with German diligence, but whether from the dearness of English books, or from some other cause, is not quite so full on the English literature of the subject as might be desirable. Another periodical, the 'Serapeum' of Dr. Naumann, published at Leipzig also since 1840, gives articles on libraries, and copies of their regulations, and also contains what is called a chronicle of libraries, in which are recorded the deaths and promotions in the little "bibliothecal" world, a branch of information which is also kept in view by Dr. Petzholdt. Some years ago there was published in England a book called the 'Encyclopædia of Literary and Typographical Anecdote,' by a printer of the name of Timperley, and though the compiler did little more in many cases than bring together in order of date, cuttings from the newspapers and magazines, relating to booksellers and printers, the volume is one that could much less easily be spared than many of higher pretensions; and keeps a place on the shelves of those who are fond of anecdote and the bye-ways of information, side by side with Hone's 'Every Day Book.' A volume on libraries on the same easy plan as Timperley's on printing, would be a very acceptable addition to our literature. The only separate book on the subject at present, is Mr. Edwards's 'Memoirs on Libraries' 2 vols., 1859, a work more ambitious but less useful, and less attractive, and in which it is remarkable how little the writer gives from personal observation, and how much from printed statements of mere detail, even in cases such as those of the history of the libraries of London and Manchester, in which both sources of information must have been open to him. With all their deficiencies, however, these volumes are, till some similar work shall supersede them, an indispensable companion to the inquirer into the history and statistics of libraries.

LIBRATION, a balancing motion, in which there is a position on one side and the other of which a body vibrates; being in fact the same in meaning as oscillation. This term is however particularly applied to a small irregularity, compounded of the moon's rotation round her axis and her orbital motion, by means of which her visible hemisphere is not always quite the same.

The mean revolution of the moon round her axis is the same period of time as her mean revolution in her orbit. If both motions were equable the moon would always present the same face to a spectator placed at the centre of the earth, on condition that the plane of her equator passed through the centre of the earth. None of these conditions being exactly fulfilled, and the variations being small and periodic, the consequence is that a small portion of the moon's surface in the eastern and western edges, and also in the northern and southern, is alternately visible and invisible. There is perhaps no subject in astronomy so difficult to explain to a reader who is not familiar with solid geometry; and the subject is not of sufficient importance to deserve any detail of illustration.

LICENTIATE IN MEDICINE. [PHYSICIANS, COLLEGE OF.]

LICHENIC ACID, a name given by Pfaff to an acid extracted by him from Iceland moss, but which has since been proved to be identical with fumaric acid. [FUMARIC ACID.]

LICHENIN ($C_{12}O_{10}H_{10}$), is a variety of starch found in the *Lichen islandicus*, or Iceland moss. It is colourless and tasteless, swelling up into a jelly-like mass in cold water, and dissolving in hot. Its solution is not coloured blue by iodine. It is converted into sugar by diluted and boiling sulphuric acid. Hot dilute nitric acid converts it into oxalic acid.

LICHENS, *Colouring matters of.* The lichens or *liverworts*, as they are frequently termed, constitute a large class of perennial plants. They are common in nearly all countries, growing on rocks, stones, trunks of trees, &c., and in appearance are very insignificant. They vary considerably in colour and size, but generally so much resemble the bark or earth to which they are attached, and over which they spread, that a somewhat close inspection is necessary before they are observed. Unimportant as they appear to be, however, it is greatly to their agency that we owe those magnificent lilac, blue, violet, purple, and many intermediate and compound colours with which wool and silk are dyed.

The English lichens are not much used for the manufacture of dyes, though were a system for their collection organised, it would probably be found that many varieties might be economically employed. Foreign lichens to the extent of 90,000*l.* worth are annually imported into this country from the south of Europe and west coast of America, but chiefly from the Canary Islands. They are principally collected from rocks in the neighbourhood of the sea.

Lichens do not contain in their natural state any colouring matter ready formed, but under the influence of air, water, ammonia, and a moderate temperature, certain acids and a neutral body existing in them are converted into a deep richly-coloured substance called *orcein*. Orcein is the dark purple or red matter that is finally produced under the above circumstances, but its formation is sufficiently gradual to admit of the process being arrested at any desired stage, and the tint if not the actual colour of the product thus varied at will. On these conditions, and on the dexterous mixture of the products with each other depends the shade of the resulting pigment, and not on the use of any particular variety of lichen. A skilful manufacturer will produce a given colour from any or all of the lichens, his only anxiety being to use that variety which contains the largest per-centage of colorific material.

The lichen colours are sent out by the maker either in the dry state, lump or powder, as a strong solution, or as a paste, conditions severally best suited to the uses to which they are applied. The details necessary to be observed in the production of these various forms of the colour are given in the respective articles on each. See ARCHIL; CUDBEAR; LITMUS.

Estimation of the value of lichens.—Lichens vary considerably in the amount of colour-producing substance contained in them. The following process, proposed by Stenhouse, is very easy of application, and gives accurate relative results. It is founded on the reaction of chloride of lime upon the colorific agent, a fugitive red colour being thereby produced. A given weight of the lichen reduced to powder in a mortar, or to a pulp with water, is digested in thin milk of lime, and the mixture filtered; a standard solution of chloride of lime is now added in small quantities at a time, fresh portions being poured in as soon as the red colour produced by the previous portion has disappeared, the addition being discontinued when no more colour is produced. The relative value of several samples can thus be very quickly determined, or the strength of the standard solution being known, the absolute amount of colouring matter is clearly indicated.

As already stated, orcein is the colouring substance ultimately resulting from the treatment of lichens for the preparation of archil, &c. Now the body from which orcein is derived is a colourless matter, named *orcin*. Orcin exists ready formed in some of the lichens, but its chief source is certain acid matters contained in all varieties of the plant. Under the influence of alkalies these acids are converted into orcin, and into secondary acids. The primary lichen acids admit of being readily extracted, and Stenhouse has proposed that the operation be performed upon the lichens as soon as gathered, the storage, freightage, &c., of a great quantity of useless material being thereby obviated. The process recommended by that chemist consists in placing the lichens in wooden barrels, which are to be filled up with water containing a quantity of slaked lime, allowing the whole to stand a short time, then drawing off the liquor and saturating it with common hydrochloric acid. In this way the lichen acids are dissolved out by the lime, but are re-precipitated by the hydrochloric acid, and after collecting on a filter may be drained, dried, and packed in casks for transit. This proposal, however, has not been adopted, or if adopted has not been persisted in; perhaps the ready-formed orcin occurs to a larger extent in the lichens than has been supposed, and not being precipitated from solution by hydrochloric acid, would be lost if the whole lichen were not acted upon.

A rough assay of lichens for colouring matter may be made by going through the above process on the small scale, a known weight of the lichen being taken, and the precipitated acids being dried at 212° Fahr. and weighed.

A list of the lichens used in the production of pigments, and a woodcut illustrating their general appearance, will be found under LICHENS, in NAT. HIST. DIV.

The acid and other bodies derived from the lichens are numerous, and as a whole have formed the subject of elaborate investigations by Stenhouse and Schunck. Their relations to each other, however, are at present not very well ascertained; and although Gerhardt has proposed formulæ calculated from the analyses and the provisional empirical formulæ given by the chemists who have examined them, he admits that those formulæ still require verification, and indicates that fact by placing a note of interrogation after the formulæ.

The following is a list of the lichen derivatives:—

1. Chrysophanic acid	$C_{20}H_8O_6$ (?)
2. Usnic acid	$C_{38}H_{16}O_{14}$ (?)
3. Erythric acid	$C_{32}H_{18}O_{16}$ (?)
4. Erythrellic acid.	
5. Picroerythrin	$C_{30}H_{20}O_{16}$ (?)
6. Erythro-mannite	$C_{14}H_{16}O_{12}$ + Aq. (?)
7. Nitro-erythro-mannite	$C_{14}H_{10}(NO_4)_6O_{12}$ (?)
8. Lecanoric acid	$C_{32}H_{14}O_{14}$ (?)
9. Orsellic acid	$C_{16}H_8O_8$ (?)
10. Pseuderythrin	$C_{16}H_7(C_4H_5)O_8$
11. Amarythrin.	
12. Telerythrin	$C_{14}H_8O_{12}$ (?)
13. Parellic acid	$C_{18}H_6O_8$ (?)
14. Rocellinin	$C_{36}H_{16}O_{14}$ (?)
15. Evernic acid	$C_{34}H_{16}O_{14}$ (?)
16. Gyrophoric acid.	
17. Everninic acid	$C_{18}H_{10}O_8$ (?)
18. Orcin	$C_{14}H_8O_4$ + 2 Aq.
19. Orcein	$C_{14}H_7NO_8$ (?)
20. Leucorcein.	
21. Chlororcein.	
22. Azoerythrin.	
23. Erythroleic acid (erythrolein ?)	
24. Litmic acid (azolitmin ?)	
25. Litmylic acid (erythrolitmin ?)	
26. Spaniolitmin.	
27. Beta-orcin	$C_{16}H_{10}O_4$

1. *Chrysophanic acid; Vulpinic acid.*—This acid is contained in wolves' lichen (*Evernia vulpina*), in yellow moss (*Parmelia parietina*), as well as in the different varieties of rhubarb. [CHRYSOPHANIC ACID.]

2. *Usnic acid; Usnein; Parietin.*—This body is obtained on treating the Jupiter's-beard, Tree-beard, and other hair-like members of the *Usnea* genus of lichens, with thin milk of lime, in the manner already described. The precipitated acid may be obtained in crystals from solution in warm (but not boiling) alcohol. Alkalies convert it into

beta-orcin. One equivalent of hydrogen in usnic acid may be replaced by one of a metal, and *usnates* formed.

3. *Erythric acid* and its derivatives, 4, 5, 6, and 7, will be found described in a separate article. [ERYTHRIC ACID.] It exists in large quantity in many lichens, and is therefore of more importance than some other of the lichen acids.

8. *Lecanoric Acid; Lecanorin.*—This acid may be extracted from the *Roccella tinctoria* and *Lecanora tartarea*, in the same way as described for usnic acid, or by direct treatment of the lichen with ether and evaporation of the ethereal liquid. It crystallises in star-like groups of needles. By long boiling with alkalies, or with lime, lecanoric acid is converted into carbonic acid and orcin; but if ebullition be continued for a short time only, the acid assimilates two equivalents of water, and a new acid is formed, to which the name *orsellic* or *orsellecic acid* (9) has been given. *Lecanorates* and *orsellates* have a constitution similar to the usnates. The orsellate of ethyl is formed when lecanoric acid is boiled for some time in alcohol; it crystallises in plates or needles, and when first discovered was called *pseuderythrin* (10). *Amarythrin* (11) is a non-crystalline substance resulting from the action of air upon orsellate of ethyl. When exposed for many months to the air, it is changed into a granular body, (12) *telerythrin.*

Alpha-orsellic acid, and *beta-orsellic acid*, were obtained by Stenhouse from the *Roccella tinctoria;* but their composition and properties are so similar, that Gerhardt thinks them identical, and notices them as ecanoric acid.

13. *Parellic acid, Parellin*, is described by Schunk as being met with in the preparation of lecanoric acid. It is slightly soluble in water, and very soluble in alcohol or ether. By slow evaporation it is obtained in colourless, brilliant, and heavy needles. Boiling alcohol does not act upon it, as upon lecanoric or erythric acids, and on this fact depends its isolation and purification. It forms *parellates* with bases.

14. *Roccellinin* is also contained in the *Roccella tinctoria.* It very much resembles parellic acid, but appears to be insoluble in water.

15. *Evernic acid* is obtained in the usual manner from *Everina prunastri*, or *Sachet lichen.* It may be crystallised from alcohol, and forms *evernates* with bases. *Gyrophoric acid* (16), from the *Gyrophora pustulata*, was first described by Stenhouse, but, according to Gerhardt, is either evernic or lecanoric acid.

17. *Everninic acid, Evernesic acid,* is a product of the action of alkalies on evernic acid, orcin being at the same time formed, possibly according to the following equation:—

$$\underbrace{C_{34}H_{16}O_{14}}_{\text{Evernic acid.}} + \underbrace{2HO}_{\text{Water.}} = \underbrace{2CO_2}_{\substack{\text{Carbonic}\\ \text{acid.}}} + \underbrace{C_{18}H_{10}O_8}_{\text{Everninic acid.}} + \underbrace{C_{14}H_8O_4}_{\text{Orcin.}}$$

When deposited from alcohol it forms silky crystals. It is isomeric with veratric acid. It forms *everninates.*

18. *Orcin* and its derivatives, *chlororcin* and *bromorcin*, will be found described in a separate article. [ORCIN.]

19. *Orcein* is the colouring matter that results from the action of air and ammonia upon the principles contained in lichens. Its immediate source is orcin, under which name it will be found more fully described [ORCIN], together with its derivatives *leucorcein* (20) and *chlororcein* (21).

22. *Azoerythrin* and *erythroleic acid* (23) are substances associated with and very analogous to, if not identical with, orcin.

24. *Litmic acid.*—The matter known in commerce as *litmus* differs only from orchil and cudbear in being formed with the additional aid of carbonate of potash. According to Kane, litmus contains *litmic acid*, at first called *azolitmin*, soluble in water, slightly soluble in alcohol, insoluble in ether; *litmylic acid* (25), (*erythrolitmin,*) very soluble in water, and but slightly soluble in alcohol or ether; and *spaniolitmin* (26), an indefinite, non-azotised body.

27. *Beta-orcin.*—Usnic acid differs from all the acids of other lichens in not furnishing ordinary orcin when treated with alkalies, but a homologue of that substance called *beta-orcin.* Beta-orcin is, however, best prepared by submitting usnic acid to dry distillation, treating the distillate with water, and evaporating to crystallisation. It may be purified by treatment with animal charcoal and recrystallisation from weak alcohol.

Beta-orcin occurs in large lustrous crystals of slightly sweet taste. It is less soluble in cold water than orcin is, but is very soluble in boiling water, in alcohol, or in ether. When heated it sublimes. With ammonia it gives a dark red colour, and with chloride of lime a blood-red.

LICHENSTEARIC ACID ($C_{28}H_{24}O_6$), a peculiar oily acid contained in Iceland moss. It forms small colourless crystals, inodorous, and possessing a bitter rancid taste, insoluble in water, but freely soluble in alcohol and ether. It is a very feeble acid, forming with the alkalies salts which resemble soap in their character.

LICKS, as they are called in North America, are small tracts of land with a sandy soil, on which salt crystallises in the form of an efflorescence, and which are resorted to by all animals that feed on grass, for the purpose of licking up the salt. They are of great importance in Brazil, where they are called *Carreiros.* The herds of cattle are there very large, and sometimes amount to nearly 50,000 head. These cattle grow lean and are reduced to bad condition if they cannot from time to time get salt, which they lick with great eagerness. When a cattle estate has no natural licks, the proprietor is put to considerable expense to provide the necessary quantity of salt for his cattle. Hence the value of a large estate is greatly enhanced by the possession of one or more licks, though in general they hardly occupy a space twenty paces long and wide. Wild animals, as deer, buffaloes, wild hogs, &c., also resort to them.

LICTOR, a public officer who attended on the principal Roman magistrates. This office is said to have been derived by Romulus from the Etruscans. ('Liv.,' i. 8.) The kings, and afterwards the consuls, were attended by twelve lictors, the dictator by twenty-four, and the master of the horse by six. The lictors went before the magistrates one by one in a line; he who went first was called *primus lictor*, and the one who immediately preceded the magistrate *proximus lictor.*

The lictors were originally chosen from the *plebs* ('Liv.,' ii. 55); but in the time of Tacitus they appear generally to have been freedmen ('Ann.,' xiii. 27), probably of the magistrate on whom they attended.

The duty of the lictor was to see that proper respect was paid to the magistrates, and to inflict punishment on those who were condemned; and probably to assist in some cases in the execution of a decree or judgment in a civil suit.

The lictors carried on their shoulders rods bound in the form of a bundle, with an axe in the middle.

The etymology of the name is doubtful. 'Gellius' (xii. 3) derives it from the verb *ligare*, because the lictor had to bind the hands and feet of criminals before they were punished.

LIEN, at common law, in respect of personal chattels, is the right in one man legally possessed of the chattels of another, to retain the same until certain present claims of the holder against the owner are satisfied. Liens are general or specific; they are implied by law, or authorised by custom or usage; or they are created by express contract between the parties. Their existence is conditional on possession, not wrongfully obtained, and uninterruptedly continued. And their purpose is, in the way of a natural remedy, to enforce simple rights, such as accrue chiefly in commerce, and such as in point of principle are too plain and obvious to admit of dispute.

For instance, upon a sale, for ready money, of a specific chattel, the right of property in the article and the right of possession immediately pass by the law of this country to the purchaser; but until the vendor actually or constructively parts with possession of the thing sold, he has a right to retain it for the price agreed to be paid, and that right is called his lien. This is one instance of a lien implied by law. The varieties of this kind of lien are numerous. As a general rule, every mechanic may retain a chattel for the price of his labour in improving it at the request of the owner. A dyer, a fuller, a packer, a tailor, who employs his labour on goods sent to him for the purpose, are familiar instances of a very extensive class. A common carrier may retain the merchandise till the carriage is paid; and an innkeeper the goods of his guest for the amount of his bill; and in both instances this is deemed a fair privilege of those persons at common law who are obliged by the same law to receive the goods or guests respectively, whenever it is not unreasonable that they should do so. But in respect of ships chartered for a particular voyage, if it should be said they do not come within the definition of carriers at common law, there is still a lien, for the freight, on the goods carried, in virtue of the improved value assumed to have been conferred thereon by their conveyance to a different market. As between attorney and client, the former has a lien on all papers in his possession for the amount of his bill; as between principal and factor, there is a lien in the latter upon all goods in his possession belonging to the former, and even on the price of them when sold and delivered, for his commission and any advances which he is under to the principal.

Lien, where not implied by law, may exist by custom. But custom in this, as in all other cases, to be legal must be reasonable, and not repugnant to the main purpose of the parties in the transaction which it is to affect. There is no lien, by law, for the agistment of cattle; but to set up a lien by custom in the case of milch cows would obviously defeat the purpose of both parties, as the owner must have possession of them in order to milk them from time to time. The training of a race-horse offers a similar illustration, since it is assumed that the owner means to enter him for different races, and must obtain possession in order to put him on the course.

As, however, it is quite competent for the parties to create a lien by their own agreement, if they are foolish enough to enter into a contract which it is either difficult or inconvenient, or even impossible to perform, the contract is good, notwithstanding, and the sufferer must take the consequences.

A general lien is a right to retain the particular goods until all the holder's claims accrued against the owner in the same course of business are satisfied. Such a lien is implied by law in favour of a factor for his general balance of commission and advances due from the same principal. Usually, however, a lien of this nature is not favoured by the law; and even where it exists by custom, as in the case of a carrier for his general account against the same consignee, the consignor may stop the particular goods *in transitu*, and obtain possession on payment of the carrier's charge in respect of them only. A specific lien, as the latter illustration may suggest, is a right to retain particular goods for claims, in respect of such goods only; it is more favoured, because less prejudicial to the interests and course of commerce.

Lien, as known to the common law, is conditional on possession of the goods being in the same hands as the right of lien. It ceases to exist the moment that possession is parted with. And though possession may have been lost unawares, the lien cannot be revived by getting possession again. Possession must be actual; but the loss of it may be constructive. If goods in the hands of a wharfinger be transferred to another name in the wharfinger's books, though not removed from their place in the warehouse, the previous holder thereby loses his lien. Or if he who has the lien procures them to be taken in execution at his own suit, or ships them for his principal on his account and risk, the lien is gone past recovery.

The possession must have been fair and legal in its commencement for any lien ever to attach. For if fraud or a trick be used to obtain possession, or otherwise it commences wrongfully, the object being to gain a lien, that object is thereby effectually frustrated.

The foundation of lien must be a present existing claim; and if the person who has such a claim, nevertheless agrees to give credit, either with or without a bill of exchange for the amount, he waives his lien and can never again resort to it. Moreover, there may be a custom to give such credit, as in the case of the Thames shipwrights, so that in the absence of express contract to the contrary, no lien arises. The person may even waive his lien by omitting all mention of it at the same time that he asserts an inconsistent claim to the goods, in presence of the sheriff; and in many other ways, a waiver of this right may take place.

With regard to real property, there is this remarkable difference, that notwithstanding the contract of sale, and the execution of the conveyance by the vendor, he retains in equity what is called the vendor's lien on the estate for the purchase money, or any part thereof that still remains unpaid. And, on the other hand, if a good title to the estate sold is not made by the vendor, the purchaser has in equity a lien on the estate for the money paid by him as deposit or part of the price.

Lien, which is not disturbed by the party, is not affected by the statute of limitations. For the lapse of time, by force of the statute, merely bars the remedy by action; but this natural remedy which the creditor retains in his own hand remains intact, and the debt continuing, there is no reason in the lapse of time why he should not continue to retain the security.

LIEN, MARITIME, differs from the foregoing in two particulars. Its existence is altogether irrespective and independent of possession of the chattel which is the subject of it. Its enforcement is not possible otherwise than by legal process. As may be supposed from the name, it applies to ships, freight, and cargo, and is a charge created sometimes by implication of the law maritime, sometimes by the express contract of the parties themselves.

The occasion of its existence is very various. Seamen have always had a lien on the vessel for their wages, without express stipulation to that effect in the shipping articles. Masters, after being long excluded from this advantage by the common law of England, have been placed on the same footing in this respect with the common sailor by the recent statute, the 17 & 18 Vict. c. 104. The collision of one vessel with another becomes immediately the occasion of lien on the offending ship for the injury sustained by the other. In like manner, salvage, towage, and pilotage, severally originate by intendment of the law a lien on the benefitted vessel for the value of the labour bestowed on it.

All these are instances of maritime lien by implication of the law maritime. There is another for which in view of the law of most foreign nations any express contract is rendered unnecessary by a similar implication of the law maritime of those several countries; but in the view of our maritime law, consequent on the restraint and repression exerted on it by the municipal law through the common law courts of England, bottomry, as it is called, has no valid existence except when it is created by the written contract of the parties, no matter in what quarter of the world or what country the claim may have accrued in. Bottomry is nothing more than a maritime lien on the hull and tackling of the ship, usually created for money borrowed, or for necessaries supplied, or repairs done to the vessel, in order to enable her to complete the voyage.

This kind of lien is indefeasible by any change of ownership not effected by sale and transfer under a decree of a court of competent jurisdiction; in all other cases of transfer the charge travels with the vessel into new hands, and no ignorance of the purchaser on occasion of the sale is a defence to proceedings for its recovery. It necessarily supposes, however, the existence of the vessel. If the ship is lost it perishes with her; and some liens at least, bottomry for instance, are such that they involve no personal claim against the owners, and no debt therefore survives the loss of the vessel. Hence it is that maritime risk is a necessary ingredient of a valid bottomry bond. It is enforceable against the ship only on condition of the vessel surviving the voyage named in the instrument.

Although this charge is indefeasible except by the destruction of the property on which it is laid, yet the maritime law in the equitable spirit requisite to the administration of law in human affairs exacts diligence on the part of the claimant in the enforcement of his rights. The Court of Admiralty is the only tribunal with a jurisdiction capable of enforcing this claim. In the other courts of this country, suits are between persons who, when property is concerned, assert a *jus ad rem.* The object of admiralty proceedings is a *jus in re*; the subject of the proceedings is the *res* itself—the ship: and the first step in those proceedings is the arrest of the vessel, to place her corporeally in the possession of the court. The adjudication which closes the proceedings is not personal, but of the thing, adjudging it to be discharged of the alleged claim or condemning it to be sold for the behoof of the claimant.

It cannot but happen sometimes that a plurality of such charges in different hands exist upon the same ship. This occasions the necessity for considering the priority of equities, which are not always, or even usually, in the order of the priority of charge. For instance, if a British vessel before departing on her homeward voyage is obliged to have recourse to bottomry, say in India, and afterwards putting in to St. Helena in a disabled state is obliged again to borrow on bottomry, and at a subsequent period of the same voyage is driven into another port in a condition to require repairs for which the master executes a third bottomry bond, the court, when the subject of the liens is not equivalent in value to the sum of the bonds, ranks these claims in the order of their equity, the last effected to be paid first, and the first last, on this presumption, that the later charge preserved the subject of the prior liens, which, although postponed in the order of payment, are really in a preferable condition than if the vessel had been entirely lost. Commerce is also favoured by such a rule. The ship is saved, and the merchandise on board is carried to its destination; whereas both must have perished for want of a lender under any other rule. Cases of a much more complicated character do occur, and the rule is not so plain, nor the consideration requisite to assign them to the proper rule so easy. There is this peculiar to wages, that the lien for them ranks first for payment. On so difficult a question, however, we must refer the reader to some such work as 'Abbott on Shipping,' by Serjeant Shee, for a full consideration of it in application to actual cases.

LIEUTENANT is an officer who discharges the duties of a superior, in his name and during his absence; and who acts immediately in subordination to him when he is present.

Thus, in military affairs, the lieutenant-general and the lieutenant-colonel are respectively the subordinate grades to the general and colonel, though in process of time the lieutenant-colonel has come to be the officer actually in command of a regiment, the colonelcy being a sinecure appointment. The lieutenant of a company is also immediately subordinate to the captain, in whose absence he has the same powers. In the British service the lieutenants of the three regiments of foot-guards have the rank of captain; in the royal regiment of artillery, and the corps of royal engineers, there being no ensigns, the subaltern officers were formerly distinguished as first and second lieutenants, but are now all styled lieutenant, the juniors having the pay of second lieutenant. The rank of second lieutenant is still continued in the royal marines. But in fusileer regiments which formerly had this rank, it has been changed to that of ensign.

In Ward's 'Animadversions of War' (1639), it is said, "A lieutenant is an officer of high credit and reputation, and he ought in all respects to bee well indoctrinated and qualified in the arts military, and not inferior in knowledge to any officer of higher authority; for an unskilful captaine may better demeane himselfe with an experienced lieutenant than an unskilful lieutenant can fadge with a skilful captaine."

A lieutenant in the royal navy takes rank as a captain in the army, and the number appointed to ships of war varies with the rate of the ship. A ship of the first rate has eight lieutenants, besides supernumeraries; those of the second, third, &c., rates, have respectively one less than the number appointed to the preceding rate; so that a sixth-rate vessel has three: sloops and bomb-vessels have only two. The monthly pay of a first-lieutenant of seven years' standing, in ships of the first three rates, and that of lieutenants commanding gun-brigs, schooners, and cutters, is 11*s.* per day. The monthly pay of other lieutenants, for ships of all rates, is 10*s.* per day.

LIEUTENANT-GENERAL. [General.]

LIEUTENANT, LORD and DEPUTY. [Lord Lieutenant.]

LIFE, MEAN DURATION OF. This is commonly called the *expectation* of life, which, properly speaking, it is not. Of a thousand lives of equal goodness, any one may expect to live as long as he has an even chance of living, that is, till 500 are extinct. This period has been denominated the *probable* life.

The mean duration of life, or the number of years which, one person with another, are enjoyed by individuals of a given age, is found from the tables of mortality, which give, out of a certain number born, the number who are left at every successive birthday. If the absolute average law of human life were given, and if $\phi x d x$ represented the chance of an individual aged n living precisely x moments of time, then $\int \phi x d x$, taken from $x=0$ to $x=$ the longest possible term of life, would correctly represent the average duration of life in persons aged n years. The tables, however, are so imperfect that it is not worth while to attempt the accurate application of the preceding formula, or to use more than the roughest of the processes which will be described in Quadratures, Method of. The theoretical imperfection of this process consists in its being necessary to suppose that the individuals who die in any one year die at uniform intervals throughout that year; so that, one with another, they enjoy half of their year of death. The mean duration of life is then constructed as follows: Let a be the number living at the age in question, of whom let b, c, d, &c., be left at the end of successive years. Then $a-b$ die in the first year, enjoying among them $\frac{1}{2}(a-b)$ years of life, while b (who survive) enjoy the whole year. Consequently the a persons enjoy, in the first year of the calculation, $b+\frac{1}{2}(a-b)$, or $\frac{1}{2}(a+b)$ years; and similarly it may be proved that they enjoy $\frac{1}{2}(b+c)$, $\frac{1}{2}(c+d)$, &c., in the second, third, &c., years. If these be put together, the result is $\frac{1}{2}a+b+c+d+$, &c., which, divided by a, gives for the average quantity of years enjoyed by each individual,

$$\frac{1}{2}+\frac{b+c+d+\&c.}{a};$$

or the rule is, add together the numbers left at every age above that given, divide by the number alive at the given age, and add half a year.

If it be judged advisable to make the preceding result a little more mathematically correct, diminish the preceding result by the 12 a-th part of $a-b$. [Mortality, Law of; De Moivre's Hypothesis.]

LIFE ASSURANCE, or INSURANCE. [Reversions.]

LIFE-BOAT. A life-boat is a boat constructed with great strength to resist violent shocks, and at the same time possessing sufficient buoyancy to enable it to float though loaded with men and filled with water. Such boats are maintained at most of the ports of this kingdom, always ready to put to sea when vessels are seen in danger of shipwreck, and provided with means for being conveyed to the shore and launched as rapidly as possible.

As early as the year 1785, a patent was granted to Mr. Lukin for a life-boat with projecting gunwales and hollow cases or double sides under them, as well as air-tight lockers or enclosures under the thwarts: these contrivances increased the buoyancy of the boat, and the air-tight cases under the gunwales, by their weight when raised above the surface of the sea, and their resistance when depressed beneath, greatly prevented rolling. Mr. Lukin's boat was strong and buoyant, but it was liable to be disabled by having the sides staved in. A better was Mr. Greathead's, invented in 1789. This boat had five thwarts, or seats for rowers, doubled-banked, to be manned with ten oars. It was cased and lined with cork, which gave it such buoyancy that it would float and be serviceable though so damaged by hard knocks as to be almost in pieces; and this is an accident which the softness and elasticity of the cork is well calculated to prevent. Greathead's boat, by the year 1804, when the Society of Arts voted the inventor their gold medal and 50 guineas, had saved nearly 300 lives from vessels wrecked near the mouth of the Tynemouth haven. In the year 1807 Mr. Wilson produced a life-boat, for which he received the gold medal of the Society of Arts, although in fact its principle did not differ much from that of Lukin's.

During the next forty years, numerous other life-boats were introduced or proposed for introduction; but all of them were wanting in some or other of the requisite qualities. In 1850 the Duke of Northumberland, as a means of lessening the terrible loss by shipwreck on the eastern coast, offered a prize for the best model of a life-boat. No fewer than 280 plans and models were sent in, which were all patiently examined by a committee appointed by his Grace for that purpose. About 50 of the models were afterwards sent to the Great Exhibition in 1851. The examiners drew up a list of all the good qualities of a life-boat, and noted down the rank of each of the 280 plans in reference to each quality; and then a summary of these partial results, gave an aggregate result for each boat, which determined the amount of its claim to the place of honour. Tested in this way, the prize was awarded to Mr. Beeching, of Yarmouth, as the constructor of the life-boat which combined the largest number of good qualities. It affords a curious comment on this mode of arriving at a judgment by prizes and competitive examinations, that the examiners did not really adopt any one of the 280 plans, although the prize was awarded to Mr. Beeching. Mr. Peake, the master shipwright at Portsmouth, who was one of the committee, designed a boat which comprised many of the features of the competitive boats, and added others suggested by his experience; and this boat, gradually improved in later years, is the one which now constitutes the recognised English model: it is adopted, to the exclusion of all others, by that highly useful body, the "Life-Boat Institution;" many boats on the same construction have been sent to Russia, Prussia, Spain, Portugal, and the colonies.

We copy from the 'Companion to the British Almanac,' for 1860, a brief description of Peake's life-boat in the latest stage of its development. The boats are of two sizes. One is about 32 feet long, 8 feet wide, 4 feet deep, weighs 40 cwt., costs 156*l.*, and is worked by 10 oars; the other is about 28 feet long, 7 feet wide, 3 feet deep, weighs 25 cwt., costs 126*l.*, and is worked by 6 oars. Although there is only one rudder, the boat is nearly alike at both ends; air-cases and chambers are provided in various parts of the interior; while ingenious arrangements are made for getting rid of any water which may have entered the boat. It is generally allowed that the boat possesses in a high degree these eight qualities—great lateral stability; speed against a heavy sea; facility for launching; ease in taking the shore; immediate self-discharge of any water entering it; facility of self-righting if upset; great strength of construction; and stowage-room for a number of passengers. Some features of the construction may be understood from the annexed cuts. In *fig.* 1, representing a vertical longitudinal section of the boat, D D are the end air-cases; 1, 2, 3, 4, 5, are transverse divisions; the dotted lines show the position and dimensions of the air-chambers within-board, and the tubes through which any shipped water is got rid of. In *fig.* 2, representing a deck-plan of the boat, A A, are the deck; B B, the relieving tubes (6 inches in diameter); C C, the side air-cases; D D, the end air-chambers. In *fig.* 3, which is a midship transverse section, A A, are sections of the side air-cases; B B, the relieving tubes, bored through solid massive chocks of wood; C C, are spaces beneath the deck, filled near the midship portion with solid chocks of light wood; while D is a section of a small channel, having a pump in it, by which any leakage-water can be pumped out by one of the crew whilst afloat. In *fig* 4, the exterior form of transverse sections, at different distances from stem to stern, is shown.

Fig. 1.—Sheer Plan.

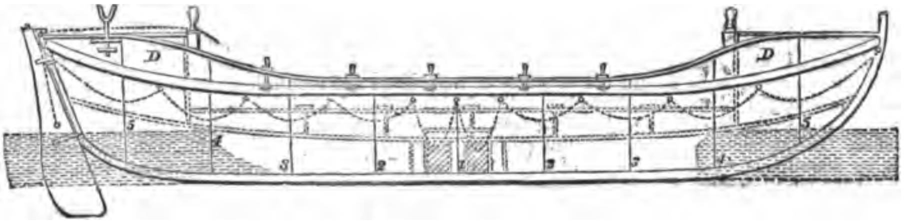


Fig. 3.—Body Plan.

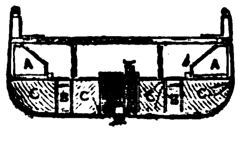


Fig. 2.—Deck Plan.

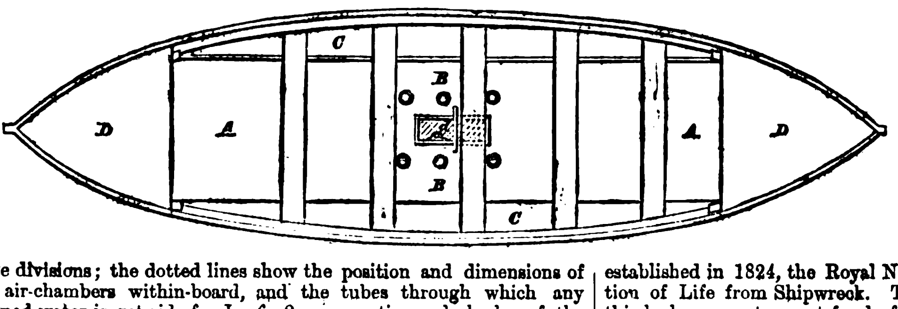
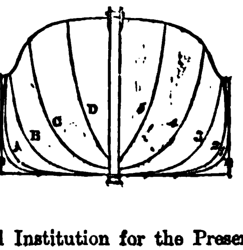


Fig. 4.—Midship Section.



The mode of managing these boats will be best described in connection with the National Life Boat Association—originally called, when established in 1824, the Royal National Institution for the Preservation of Life from Shipwreck. The objects sought to be attained by this body were—to grant funds for making life-boats, boat-houses, and life-buoys; to assist in training boatmen and coast-guardsmen to aid ships in distress; to interchange the fullest information, with corporate bodies and local committees, concerning life-saving appliances; and to reward by money, medals, and votes of thanks, those who might render aid to ships in distress, or to persons escaping from such ships. During a course of 31 years, from 1824 to 1854 inclusive, this useful society was instrumental in saving the lives of 9222 persons from shipwreck—not that the work was all done by this Institution; but that it took its share in a series of well-planned efforts having this as the result. In 1854 came into operation an Act relating to merchant ships and merchant seamen (17 & 18 Vict. cap. 104: "An Act to amend and consolidate the Acts relating to Merchant Shipping"); by which the supervision and control of such ships was vested in the Board of Trade. Its provisions, among other important matters, related to life-boats. Another benevolent society, the "Shipwrecked Fishermen's and Mariners' Royal Benevolent Society" transferred some life-boats, eight boat-houses, and five life-boat carriages, to the Life-Boat Institution; the two societies took up more clearly defined lines of action than before; and both gave up certain objects which the new Act enabled the Board of Trade to attain more effectually. Since that year, the Life-Boat Institution has greatly extended the series of life-boat stations. In November, 1859, there were 88 life-boats belonging to the Institution, besides about 70 others belonging to various harbour commissioners, dock trustees, Trinity houses, ballast boards, fisheries' commissioners, local committees, and associated boatmen. The Institution furnishes every possible aid to the crews of the life-boats, to whomsoever belonging. In each case there is a boat-house in which to shelter the boat from the weather; and in many instances a carriage on which to launch it. The crews are resolute and steady men, kept to their work by a well-considered arrangement between them and the Institution.

A useful little manual has been published by the Institution; giving instructions how to manage the life-boats. This manual has recently been translated into French by Admiral Paris, for the use of French boatmen.

Although applicable to ordinary ships' boats rather than to life-boats, we may briefly speak of the apparatus for quickly lowering boats. Many lives have been lost through the imperfect way in which boats are hung from the davits over the ship's sides; insomuch that during wreck or burning, either the boat occupies too long a time in being liberated, or it is capsized during its descent. Mr. Lacon, Mr. Berthon, and many other inventors, have turned their attention in this direction, with a view to devise a remedy. Captain Kynaston's *disengaging hooks* are connected with a somewhat intricate but very ingenious apparatus by which boats can be lowered quickly and safely, by persons in the ship (not in the boat). Messrs. Wood and Rogers' apparatus more recently introduced, is in a similar way worked by the seamen on shipboard. But the most original and effective apparatus is that invented by Mr. Clifford, in which the boat is lowered by one person *seated in the boat itself*, even although there be the weight of a dozen other persons in the boat. There are ropes, blocks, pulleys, rollers, hooks, and other apparatus so cleverly arranged, that the manager of the boat can first lower it to the water's level, and then disengage it altogether from the ship.

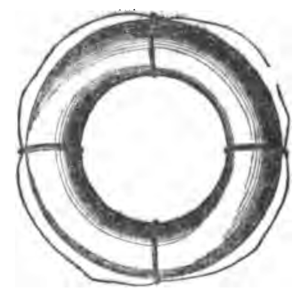
Besides life-boats constructed for the especial purpose, there have been several inventions for converting ordinary ships' boats into life-boats upon a sudden emergency, which may be applied by the crew of a ship in distress. The Rev. Mr. Bremmer proposed that empty casks should be strongly fixed in ships' boats upon a plan described by him, which on trial was found to answer perfectly. The silver medal of the Society of Arts was voted to Mr. Bray for an invention by which air-tight boxes should be fixed under the thwarts of ships' boats to render them buoyant; but these could not be applied extemporaneously, like some of Mr. Bremmer's plans.

LIFE-BUOY. Any thing being lighter than water, used as a means of personal safety on account of its buoyancy, may be considered a life-buoy. A variety of substances have been tried in various combinations for the purpose of assisting to save life, but seamen differ as to the qualifications or advantages possessed by certain forms of life-buoy. Many ingenious contrivances have been invented and attached to the taffrail of a ship, from which, in case of sudden accident, such as the falling of a man overboard, a buoyant substance could be instantly detached for the relief of the unfortunate person. Some of these have even the means of igniting a blue light for the guidance of the man in the water, by the mere act of letting go. The life-buoys referred to are generally formed of two small casks connected by a strong beam, having a vertical staff thereto attached. Occasions have happened in which a miserable man has been supposed to have reached the buoy which had been cast adrift for his safety, but which a heavy gale or dark night had deprived the crew of all possible means of recovering. It is, however, a point of conscience among seamen, never to leave a buoy adrift on the ocean if recoverable, for fear of abandoning the unfortunate occupant to the worst of all deaths, namely that of starvation.

Many kinds of life-buoys have been made of India-rubber, and adapted for ready inflation by the wearer within the period of a few seconds. One sort is in the form of a waistcoat. But the buoy which seems to have most successfully won its way among seamen of late years is that represented in the annexed cut.

It is composed of slices of cork, so nicely arranged as to form a buoyant zone of about 32 inches extreme diameter, and 6 inches in width, with a thickness of about 4 inches, and containing about 12 pounds of cork, compactly covered with painted canvas and furnished with looped life-lines, as in the drawing.

Taking the cubic contents of the buoy as ·86 of a cube foot, and sea-water at 64 pounds the cubic foot, while the cork in the buoy would weigh 12 pounds, and thus leaving at least 40 pounds as extra buoyancy, one of these life-buoys would support about six ordinary human beings. A man of 10 stone, in sea-water is commonly reckoned to weigh 4 pounds; the more he frantically forces his head out of water, the more buoying power he will of course require; but allowing for weight of clothes, &c., say, altogether, to the amount of 10 pounds each man, this buoy would support four men with certainty.

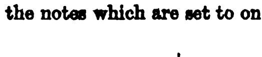


It is greatly to be desired that human life afloat should be better protected by the means of safety in case of accident afloat. The prejudice against life-buoys is greatly diminishing in the merchant service; and the extraordinary exertions made by the National Life-boat Institution, and the success of their precautionary measures in providing for those in their employ upon the coast, has tended to show that it is no imputation on the courage of a brave man that he seeks to protect his life.

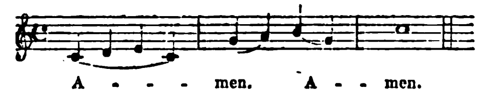
LIFTING, on Easter Monday and Tuesday. A custom which formerly prevailed among all ranks throughout the kingdom, and may be yet partially practised in some of our distant counties. In Pennant's time it was not uncommon in North Wales. Strange as it may seem, this custom is intended to represent, or rather to commemorate, our Saviour's resurrection. The lifting of King Edward I. in his bed, on the morning of Easter Sunday, by a party of the ladies of the bed-chamber and maids of honour, together with the fee paid to them upon the occasion, occurs upon the accompts of the comptroller of the household of the eighteenth year of that king, preserved in a record in the Tower of London, communicated by Samuel Lysons to the Society of Antiquaries, in 1805.

LIGAN. [FLOTSAM.]

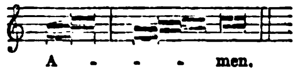
LIGATURE, in modern music, a binding, indicated by a curved line, ⌒. If two notes on the same degree are thus joined, only the first is to be struck, but the second is to continue its full time. *Ex.:*



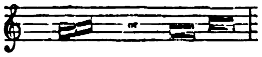
In vocal music all the notes which are set to one syllable are bound together. *Ex.:*



In music in the old character, that is to say consisting of longs and breves, the notes in *ligature* were joined, that is, were written or printed side by side. *Ex.:*



And sometimes the two characters were blended into one. *Ex.:*



But the ancient ligature is now become obsolete, and any further explanation of it is unnecessary.

LIGATURE. [SURGERY.]

LIGHT. The laws which govern the phenomena of light, when propagated through a vacuum or a uniform uncrystallised medium, form, with the exception of the laws of reflection, the only branch of optics with which the ancients had a scientific acquaintance. The discovery of single and double refraction, of chromatic dispersion, polarisation, and of mutual interference as exhibited in the various experiments of diffraction, have formed both to the practical and scientific men of modern times the sources of exploration in the grandest phenomena of the physical world, as well as in those which belong to the most delicate scale.

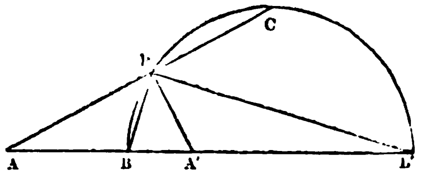
The first branch of this subject has been called photometry, and is confined to light emanating from whatever sources, but unmodified in its progress through space by any external influences, though strictly speaking photometry relates to the comparison, as to intensity, of two streams of light under all circumstances. [PHOTOMETER.]

In our cognisance of the form of objects by the sense of feeling, the hand or other part of the body is brought into contact with the object of our perception, and by some ancient philosophers it was supposed that in like manner rays of *sight* were emitted from the eye in straight lines, and by their impulse on distant bodies caused our perception of their form and colour. But on examining the structure of the eye [EYE] we find that to whatever luminous object we direct the optic axis, an image of the object is depicted on the retina in connection with a system of nerves, in the same manner that similar pictures are formed by mechanical contrivances, such as lenses upon screens, &c.; hence it is obvious that vision is caused by light proceeding from the observed object. Now since bodies are perceptible in all positions, it follows that light emanates from luminous bodies in all directions; and as to opaque bodies, the light which falls on the irregularities of their surfaces is in a great measure afterwards scattered in all directions, by which they become visible to any number of observers.

Suppose that a luminous point is enveloped by a spherical surface of a certain radius, but having that point placed at its centre, the surface will be obviously illuminated all over uniformly with a brightness or intensity depending on the magnitude of the radius. We can ascertain the connection between this brightness and the radius, by supposing the light from the same source diffused over another and concentric spherical surface of a greater or less radius; it will evidently be more or less intensely diffused in the exact proportion in which the one surface is less or greater than the other. Now spherical surfaces are proportional to the squares of the radii, therefore the intensity of light proceeding in vacuo from any luminous origin must be in the inverse proportion of the square of the distance from that point. We have employed the term *proceeding* as applicable to light, because that by two independent astronomical phenomena, namely, the aberration of light, and by the retardation of the eclipses of Jupiter's satellites, we are alike taught that light, whether of the sun, planets, satellites, or fixed stars, is not propagated instantaneously throughout space, but travels with a velocity in round numbers of 192,000 miles per second. Within the last few years M. Fizeau has succeeded, by a most ingenious contrivance, not only in rendering sensible the time which light takes to travel the distance of a few miles, but even in measuring its velocity by direct experiment. ('Comptes Rendus,' tom. 29, p. 90.)

A ray of light has its origin at a luminous point, whence it diverges in an infinitely small solid or conoidal angle, and is the geometrical element of the total spherical emanation of that point. These rays proceed in straight lines in vacuo or a uniform medium, for no opaque body can screen the luminous point from view, except when placed in the straight line joining the eye of the observer with the origin of the light, or, which is the same, we cannot see through bent tubes; but the modifications suffered by light at the surfaces of bodies, and in the interior of media, cause generally a deflection, sometimes sudden, at others gradual, in the direction of the ray.

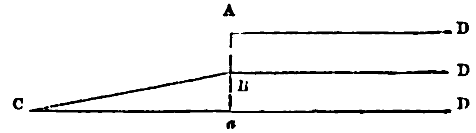
If the intensity of light emanating from a luminous point, that is, the illumination of a unit of spherical surface having a unit radius, be represented by i, and a small plane, of which the area is a, be exposed to the same light at a distance r from the origin, and situated perpendicular to the luminous ray, the quantity of light which it receives will be represented by $\frac{a\,i}{r^2}$; but if the plane, instead of being perpendicular, be inclined to the direction of the ray at an angle α, the total illumination of the plane will then only be $\frac{a\,i}{r^2}\sin\alpha$, for $a\sin\alpha$ is the area of the plane projected in a direction perpendicular to the ray, and this projection at the same distance would evidently receive the whole of the light which fell on the inclined plane: we shall give a few examples of these formulæ.

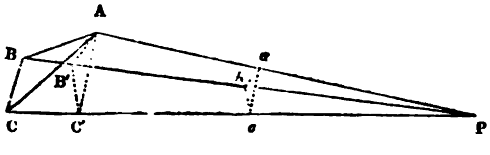


Suppose that A, A′ represent two lights of the respective intensities i, i', and that P B, P B′ are planes which bisect the angles A P A′, C P A′, respectively; the angle B P B′ is obviously then a right angle, and the plane P B as well as P B′ will be equally illuminated at the point P by the two lights, provided $\frac{i}{\text{AP}^2}=\frac{i'}{\text{A}'\text{P}^2}$, that is, provided $\frac{\text{AP}}{\text{A}'\text{P}}$ be the constant $\left(\frac{i}{i'}\right)^{\frac{1}{2}}$; then by Euclid, book vi., $\frac{\text{AB}}{\text{A}'\text{B}}$ is equal to the same constant, by which the point B may be found, and $\frac{\text{AB}'}{\text{A}'\text{B}'}$ being still the same, B′ is similarly known; hence if on B B′ as diameter a circle be described, each point, such as P, will have the property that planes directed through it to either extremity of the diameter will be equally illuminated by the two lights; but the different portions of the curve itself do not possess this property, which may be too readily supposed from the inaccurate statement of this question in optical treatises.

Let it now be proposed to find the nature of a curve, every element of which shall receive equal illuminations from two given lights. Let r, r' be the radii vectores to any point drawn from the two poles or lights, and θ, θ' the angles which r, r' make with the axis or line joining the lights internally; then s representing an arc of the curve, the sines of the angles at which r, r' are inclined to an element of the curve are $r\,\frac{d\theta}{ds}$ and $-r'\,\frac{d\theta'}{ds}$; and representing the intensities as before, the condition of equal illumination gives the equation $\frac{i}{r^2}\cdot\frac{r\,d\theta}{ds}=-\frac{i'}{r'^2}\cdot\frac{r'd\theta'}{ds}$: whence $\frac{d\theta'}{d\theta}=-\frac{i}{i'}\cdot\frac{r'}{r}=-\frac{i}{i'}\cdot\frac{\sin\theta}{\sin\theta'}$ by trigonometry. Integrating we find $i\cos\theta+i'\cos\theta'=$ const. which (together with the common trigonometrical equations) gives the polar equation of the curve sought. We should obtain a negative sign, instead of a positive, if we supposed the curve equally illuminated on opposite sides.

Having now considered the laws of the emanation of light from points, we are next to consider its emanation from luminous surfaces, particularly when the direction of the light is oblique to that of the surface. To this end suppose A B, B C to be two planes of equal luminosity relative to a unit of either, and regarding only that portion of the light which emanates in the directions A D, B D, C D, perpendicular to A B produce A B to meet C D in the point a, and suppose the extent of B C to be taken such that B a = B A, then B C will seem to the eye (receiving the rays in the directions A D, B D, C D) to be of the same extent as its projection B a, or as that of B A; but as its luminous surface is greater, it would appear brighter than B A in the ratio of B C to B A or B a, if the intensity of the oblique emanation from C B were equal to that of the direct emanation from B A. Now we know by experience that it has only the same brightness as its projection, for if we take a bar of heated iron into a dark room, it appears no brighter when viewed obliquely than direct, the only observable difference being in apparent size, which is that of the projection of the bar on the line of vision: hence it follows that the emanation from a unit of the oblique surface is less than that of the direct, in the ratio of B a to B C, or, which is the same, as the sine of the angle of emanation B C D is to unity. After emanation it follows the same law as direct light, of diminishing in intensity inversely as the square of the distance. This law has been the subject of much contention, but we may remark that something similar occurs in the action of electro-dynamic currents, which, though they follow the law of the inverse square at different distances in a given direction, yet in different directions the intensity varies in a trigonometrical function of the directions of the currents acting and acted upon, and the line of junction. The law above mentioned we should not be warranted in applying to luminous gases, as, for instance, the flame of a candle, since the light of the different parts freely then permeates the mass.



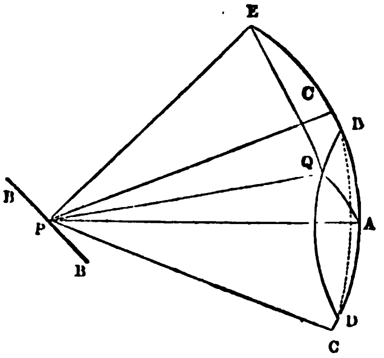


Let A B C represent a small luminous plane, situated obliquely with respect to a point P and A B′ C′, its projection taken perpendicular to P A, and finally $a\,b\,c$, a similar plane to the latter taken at a distance P a = unity, the quantity of light emitted by A B C to the point P is the same as if it proceeded from A B′ C′, and is therefore represented by $i.\ \frac{\text{Area AB}'\text{C}'}{\text{PA}^2}=i.\ \frac{\text{Area } abc}{\text{P}a^2}=i.$ Area $(a\,b\,c)$, where i represents the intensity of the given luminous plane; hence if we have any luminous surface, we may, by dividing it into very small elements, transfer each element to another situated at a unit of distance from the illuminated point; in other words, we may substitute for this surface that portion of a spherical surface with radius unity which would be cut out by a conical surface having P for vertex and exactly enveloping the luminous surface. The calculation of the illumination of any small plane by a luminous surface of any figure is thus reduced to that arising from a portion of a spherical surface having that plane placed at its centre.

Example. A distant luminous sphere subtends a given angle 2 α at the eye of an observer: to find its total illumination of a small plane area A placed at the eye and inclined at a given angle β to the right line joining the eye and the centre of the luminous sphere.

Let B P B represent the small plane; with centre P and radius unity describe a circular arc C A C, of which the measure is 2 α, and which by rotating round its axis P A generates a spherical surface of equal illuminating power with the given sphere. Let the angle B P A = β.

Take a radius P Q forming an angle A P Q = θ, and which, by revolving round P A, traces the circle D Q D. The plane B P B is taken perpendicular to the plane of the diagram. Let ω be the inclination of P Q to the given plane. The spherical element at Q is $\sin\theta.\ \delta\theta\,\delta\phi$, where ϕ is the inclination of the plane APQ to that of the diagram, and its



lluminating power is therefore $i\sin\omega\sin\theta.\ \delta\theta\,\delta\phi$, therefore the total illumination is expressed by $A\int_{\theta}\int_{\phi} i\sin\omega\sin\theta$, the limits of ϕ being 0 and 2π (where π is the semicircumference to a unit radius), and of θ being 0 and α. When the intensity is uniform, we get the illumination $I = A\,i\int_{\theta}\int_{\phi}\sin\omega\sin\theta$. Draw PE perpendicular to the plane BB; then in the spherical triangle QAE we have $QA = \theta$, $\angle QAE = \phi$, $AE = \frac{\pi}{2} - \beta$, and $QE = \frac{\pi}{2} - \omega$; hence by trigonometry

$$\sin\omega = \sin\beta\cos\theta + \cos\beta\sin\theta\cos\phi.$$

Hence $\int_{\phi}\sin\omega\sin\theta = 2\pi\sin\beta\sin\theta\cos\theta\ .\ .\ .\ .\ .$ and now integrating relative to θ, we have $I = Ai.\ \pi\sin\beta\sin^2\alpha$, as the illumination required. In this investigation the whole of the light is supposed to fall on the same side of the plane.

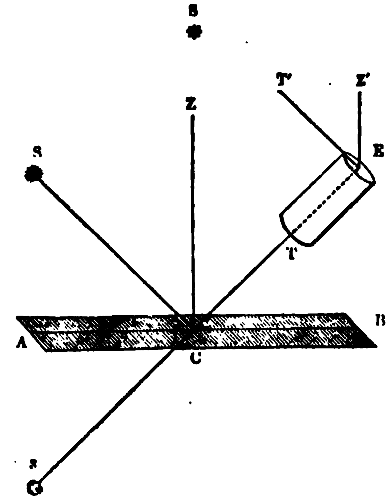
If a small hole be formed in the window-shutters of a darkened chamber, the rays of light passing from opposite parts of any luminous object outside cross each other in entering the orifice, since they necessarily proceed in straight lines, and therefore form on the opposite wall of the chamber a perfectly inverted image of the external object, and if the latter be in motion, the image will also move in the contrary direction. If m be the magnitude of the object, and x its distance from the hole, and a the width of the chamber, then the light being supposed to enter directly, the magnitude of the image, by the known laws of similar figures, will be $m.\frac{a^2}{x^2}$. But the total quantity of light which enters the hole (supposed to be of given size) from the object varies as $\frac{1}{x^2}$, that is, as the magnitude of the image, a being supposed constant, and therefore the brightness of the image is constant for all distances of the object. The eye is such a chamber, and therefore a luminous object should appear of equal brightness at all distances, but the absorption of light by the atmosphere causes the greater dimness of distant atmospheric objects.

If we suppose the quantity of light absorbed by a transparent medium to be a proportional part of the incident light, then denoting by i the intensity of light which corresponds to a space x traversed (or rather, to include the case of divergence, the *ratio* of the intensity to what it would have been independently of absorption), we shall have $\frac{di}{dx} = -k.\ i$, k being a constant dependent on the particular nature of the medium, and by integration we find $i = I.\epsilon^{-kx}$ where I is the initial intensity previously to the light entering the medium, and ϵ the base of Napierian logarithms; therefore the intensity will diminish in a geometrical progression for equal spaces successively traversed.

From these principles we are enabled to calculate the laws which the direct rays of light obey, from their emanation to their incidence. If the body on which the latter takes place be unpolished and opaque, a portion of the light enters into it for a small depth, and is there partially absorbed; the complementary portion is scattered in all directions; the surface therefore becomes itself, to that extent, a source of light, but the composition of the differently coloured rays [DISPERSION] may be widely different from that of the incident light: for instance, if the incident light were an equal mixture of red and blue rays, and if the surface favoured the absorption of the latter more than of the former, the scattered or complementary light, then containing more of red than blue rays, would proportionally tinge with red the apparent colour of the surface. Solar light is a compound of various homogeneous coloured rays; and by their unequal absorption or transmission bodies acquire these apparent colours; but the perception of form arises from the variations of light and shade, and the modifications of light on the borders, ridges, and angles of the surfaces; and the painter, when he produces a relief on a plane surface, imitates those modifications in the colours which he applies. Hence the perception of form is lost when this incident light is excluded, as in a heated square bar of iron in a dark room, which when turned round its axis seems always to be a flat surface, growing wide and narrow alternately as its edges or faces are turned to the eye; and even when incident light is admitted, a greatness of distance from the eye renders those modifications inappreciable unless under the most favourable circumstances; and thus the heavenly bodies, instead of appearing as round solids, are projected upon a spherical surface, having the eye for the centre. When the body exposed to incident light has even a slight polish, the scattered light will then be most copious in the directions in which the *regular reflections* take place. Such portions of the surface as are situated, relatively to the eye, properly for regular reflections of the incident light, have therefore a much greater apparent brightness than the parts adjacent, and thus assist in producing the ideas of the position and form of the parts.

When the polish of the surface is such that the irregularly scattered rays bear but a small proportion to the regularly reflected light, we become then principally sensible of the effects of the latter in producing *images* of all the bodies of which the incident light is reflected to the eye: we are thus led to consider the laws of regular reflection.

Let AB represent a surface of mercury at rest, and therefore perfectly horizontal; ET the axis or line of collimation of a telescope, by which we perceive s the image by reflection of the star S, and let the angle ACs of its apparent depression below the horizon be measured. Then, turning the telescope in the vertical plane ZCE until its line of collimation takes a position T′E, in which the star itself becomes visible, and measuring its apparent zenith distance T′EZ′ or SCZ, this angle is found invariably to be the complement of the former angle ACs. Now, ZCT being the complement of ACs or TCB, it follows that the angles ZCS, ZCT are equal.



This experiment demonstrates that the reflected ray CT is in the same plane ZCS as the incident ray CS and the normal CZ, and that the angle formed by the reflected ray CT and the perpendicular to the surface—that is, TCZ, or the *angle of reflection*—is equal to SCZ, the *angle of incidence*. Such are the laws which govern the reflection of light.

Let us suppose that light consists of a succession of particles emitted from the luminous body at intervals sufficiently short to produce vision, which hypothesis is generally known as that of *emission;* then the preceding law would result from the supposition that the luminous molecules, on approaching and entering the reflecting medium, are subject to forces proceeding from this medium, and of which the resultant is normal to the surface. For conceive the velocity of the luminous particle as it enters the medium—or rather, as soon as it comes within the influence of its forces, to be decomposed into one parallel and one normal to it. The force of the medium can exercise no influence on the former, and it is therefore the same at the exit of the ray from the influence of the medium as at its entrance. Again, the effect of the normal force on the square of the normal velocity in a space small enough to consider the force uniform, is the product of twice this force and the small interval of space, and it is therefore the same in increasing this quantity for the returning as in diminishing it for the incident ray; and therefore the normal velocities of the incident and reflected rays are equal, as well as the parallel; from whence it necessarily follows that the angles of incidence and reflection are equal. It admits of easy geometric demonstration that the path of the ray between any fixed points in the incident and reflected parts is a minimum (neglecting the insensible curvilinear part), in reference to any other supposed positions of these rays, when the reflecting surface is plane, or any curved surface which is tangent externally at the point of incidence to a spheroid having the fixed points for foci, and the length of the ray between them as axis major; for those touching the spheroid internally it is a maximum.

If we suppose that light is propagated by undulations in a rare elastic medium from the luminous point as an origin, the velocity of the waves, after reflection, is the same as before incidence, since the medium is the same; and hence, as in sound, the angle of reflection would still be the same as that of incidence. [ECHO.] Thus both the hypotheses of emission and of undulations satisfactorily account for this fundamental law.

If the reflected ray of light were transformed to an incident, reciprocally the path of the incident would become that of the reflected. The same is true for any number of reflections at different surfaces.

The *deviation* of a ray of light, after it has undergone any alteration in its course by the action of media, is the inclination of the primitive and final directions of the ray taken in the sense in which they are moving. This deviation by one reflection on any surface is the supplement of double the angle of incidence, or is the double of the inclination of either ray to the medium.

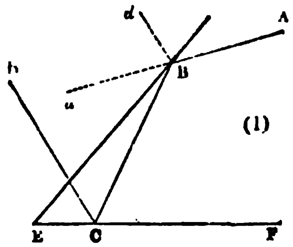
A *plane of reflection* contains a successive incident and reflected ray, and is necessarily perpendicular to the corresponding reflecting surface.

When there are successive reflections, the inclination of the plane of the first to that of the last reflection is the *deviation in plane*, the last ray being then in a different plane from the first, the first kind of deviation, or that of direction, is the angle between the first ray produced beyond the incident point (which is the course the ray would have pursued if unreflected), and a parallel to the last ray drawn from the same incident point.

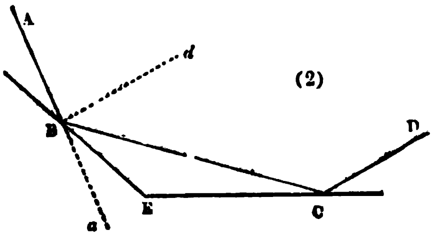
When light is reflected by two parallel planes there will be neither deviation in plane nor in direction; more generally there will be no deviation in plane when the first incident ray is in a plane perpendicular to the intersection of the two reflecting planes.

In the latter case, where both reflections take place in the same plane, let us consider the amount of the deviation in direction.

Let A B C D represent the course of the ray reflected at B and C by the reflecting planes E B, E C. Let B *a* be the first ray produced, and B *d* the parallel to the final ray; then the angle *a* B *d* is the deviation. When the other two rays are at opposite sides of the intermediate ray B C (*fig.* 1), then the deviation of C D from A B is the *difference* of the two deviations at B and C, or twice the angle B C F—twice the angle C B E, that is, 2 ∠ E, or double the inclination of the mirrors. But when A B, C D, are at the same side of B C (*fig.* 2), the total deviation is the *sum* of the deviations at B and C, or twice the angle E B C + twice the angle E C B, which is the same as 360° − 2 ∠ E. This is a re-entrant angle when E is acute, and therefore we may then substitute for it the corresponding natural angle 2 ∠ E. Hence the deviation is double the inclination of the mirrors when acute, and double its supplement when obtuse. This property is turned to excellent use in Hadley's sextant. In general, when there are any number of reflections in one plane, the total deviation is the sum of the deviations at each reflection, giving negative signs to those where the rays are turned in a contrary way to the first reflection; this sum is independent of the first angle of incidence when the number of planes is even.



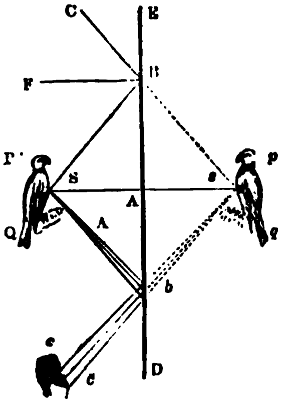
(1)



(2)

With the exception of this case, the ray will deviate not only in direction but in plane. The following results may easily be proved to be true of the course of a ray reflected any number of times at any number of mirrors which are parallel to the same line:—The inclination of the ray to the above line will be constant throughout its course, and the projections of the rays on a plane perpendicular to the mirrors will obey the law of reflection of rays coinciding with those projections.

When light diverging from any luminous point falls on a plane reflecting surface, it will after reflection diverge accurately from a point similarly situated at the opposite side of the mirror. Let S be the luminous point, DE the mirror, draw SA perpendicular to the mirror, and produce it until As = AS; let SB be an incident ray, join sB, and produce it to C, then it is evident that ∠ SBA = ∠ sBA = ∠ CBE. Now BC, being in the normal plane SAB, and making, with the normal BF, an angle CBF equal to the angle SBF of incidence, must therefore be the reflected ray. The position of *s* being independent of that of B, the point of incidence, it follows that every other reflected ray *bc* will diverge from the same point. Thus the reflected light will appear to an eye *c* as if proceeding from a point *s* behind the mirror similarly situated with S.



Hence if any *body* PQ be placed before a mirror DE, the light which emanates from P will *appear* after reflection to proceed from the similarly situated point *p* behind the mirror, and thus an *image pq* exactly similar to the body PQ will be seen by looking at the mirror; the common looking-glass is a familiar example.

If we seek generally the nature of a surface by which light converging to or diverging from one given point may after reflection diverge from or converge to another, it will be simplest to seek first the plane curve possessing the same property, then the surface generated by the revolution of this curve round an axis passing through the two given points will evidently be of the nature required.

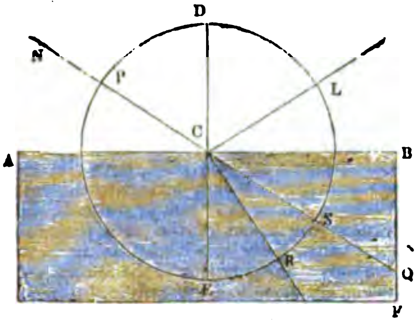
Let r, r' be the radii vectores drawn from a point of the curve to the given points, one will correspond to an incident, the other to a reflected ray; and let s be an arc of the curve measured from a fixed point to that of incidence, then $\pm \frac{dr}{ds}$ is the sine of the angle of incidence, using the upper or lower sine according as r increases or diminishes with s; hence we must have $\frac{dr}{ds} \begin{smallmatrix}+\\-\end{smallmatrix} \frac{dr'}{ds} = 0$, whence $r \pm r' =$ const. Taking the upper sign we have an ellipse, or with the lower an hyperbola, of which the two fixed points are the foci: hence the prolate spheroid and hyperboloid are the surfaces sought. But if the incident light fall in parallel rays, and is reflected to one point, take the axis of x through this point in the direction of the rays, the sine of incidence is then $\pm \frac{dx}{ds}$, whence $\frac{dr'}{ds} \pm \frac{dx}{ds} = 0$, $r' \pm x =$ const., which is the equation to a parabola having the given point for focus; therefore the paraboloid of revolution is the required surface.

But when light diverging from a point falls on a surface, after reflection it generally does not again converge to a point, or diverge from one accurately, nor does even an infinitesimal pencil in general after reflection pass through a focal point, but only through two infinitesimal focal lines, lying in two rectangular planes passing through the pencil. These lines lie respectively on two sheets of a surface, which may be called the caustic surface, which is touched in each sheet by every ray of the system. The consideration of caustic surfaces is, however, ordinarily restricted to the case of a system of rays symmetrical about an axis, in which case one sheet merges in a line along the axis, and the other, to which the term *caustic* is ordinarily restricted [CAUSTIC], becomes a surface of revolution, generated by the revolution of the curve of ultimate intersection of the rays which lie in any plane passing through the axis. The equations and properties of caustics are, however, rather objects of analytical exercise than of any practical use. [OPTICS.]

In the case of reflection, the light is returned to the medium in which it moved previous to incidence; but when a ray of light is incident on a transparent medium of greater density than that of the medium in which it originally moved, a portion of it is reflected, but another portion enters the medium, and then proceeds generally in one straight course in the plane of incidence, but not in the original direction, having a deviation *in course*, though not *in plane*, and sometimes, as in certain crystallised media, it splits into two rays, one in the plane of incidence as before, the other in a plane determined by the nature of the crystal, while in other crystallised media it splits into two rays, of which neither lies in the plane of incidence. The same phenomena take place when light passes from a dense to a rarer medium, except that in this case the whole of the light may under a certain incidence be totally reflected.

This alteration of the path of light passing from one medium to another, which is familiarly observed in the apparently bent form of a straight stick partially immersed in water in an oblique direction, is called refraction. As double refraction is of comparatively rare occurrence among the instances of refraction which ordinarily fall under our notice, we shall first attend to the laws of single refraction.

Let N P C represent a solar beam in vacuo and incident at C on a transparent medium (as water), to the surface of which D C E is normal.



When the medium is fluid, place a graduated circle D S E in the plane of incidence with its centre at C; a portion of the light will be reflected in the direction C L, and another entering the medium will be refracted in the direction C R. If uninfluenced by the medium, its direction would have been C S. The angle R C E is the angle of refraction, D C N or E C S of incidence, and S C R of deviation. The arcs D P, D L, are equal by the law of reflection, and if we compare the arcs D P, E R, their sines will be found in a constant ratio, depending on the nature of the medium, but independent of the angle of incidence. Thus if I be the angle of incidence, and R that of refraction, the two are connected by the simple relation $\sin I = \mu \sin R$. The constant μ peculiar to the medium is called its *index of refraction*. When the medium is solid, we can easily compare the tangents of the angles, and thence their sines. The above law will be found rigorously exact.

This law may be accounted for on the theory of emission. Let V be the velocity of the ray before incidence, which is decomposable into a horizontal velocity, $V \sin I$, and a normal one, $V \cos I$. The former will not be affected by the medium; the square of the latter will be increased at the confines of the medium by a quantity n^2, which is the sum of the products of twice the force into the element of the normal throughout that inappreciable space in which the forces of the medium do not destroy each other, in consequence of proximity to the urface. Therefore the normal velocity of the refracted ray is $\sqrt{\left\{V^2 \cos^2 I + n^2\right\}}$ and its actual velocity $\sqrt{\left\{V^2 + n^2\right\}}$; so that the horizontal velocity in the medium is $\sqrt{(V^2+n^2)} \sin R$, which being equated with $V \sin I$, its value before incidence gives $\sin I = \mu \sin R$, where $\mu = \frac{\sqrt{(V^2+n^2)}}{V}$

How are we to account for the reflected ray C L? Why is not the whole incident light refracted? Even when the incident light is perpendicular to the refracting surface, a portion of the light is reflected; and when the ray has but a very small inclination to the surface, a portion will yet be intromitted. Hence we may consider generally that the incident light consists of portions which are differently disposed to be subject to the repulsive and attractive forces of the medium, or, in Newton's language, are in *fits of easy reflexion or transmission*. When the angle of incidence increases, the normal velocity of the ray diminishes, the effect of the repulsive forces is therefore augmented, or the reflexion is more copious.

If r, r' be any portions of the incident and refracted rays measured to fixed points in their directions, and V, V' the corresponding velocities, and we make A C B the axis of x, we have $\sin I = \frac{dr}{dx}$, $\sin R = -\frac{dr'}{dx}$, and since $V \sin I = V' \sin R$, therefore $\frac{d}{dx}(Vr + V'r') = 0$; and $Vr + V'r' =$ minimum, which result is agreeable to the dynamical principle of least action.

On the undulatory theory each portion of an incident wave, as it arrives at the reflecting and refracting surface, is conceived to be the centre of a disturbance which spreads out in each medium with the velocity of propagation appropriate to that medium. Thus, setting aside the incident waves, the disturbance in the two media is conceived of as the aggregate of the disturbances due to these various elementary or secondary waves, a mode of conception the legitimacy of which rests directly on the general dynamical principle of the superposition of small motions. In this way the laws of reflection and refraction are simply deduced [UNDULATORY THEORY OF LIGHT], and with respect to refraction, it is shown that the ratio of the sine of incidence to the sine of refraction is that of the velocity of light in the first medium to its velocity in the second. Hence, according to this theory, light must travel more swiftly in vacuo than in a refracting medium in the ratio of μ to 1, while, according to the theory of emission, it must travel more slowly in the inverse ratio. This leads to a crucial experiment for deciding between the two theories, which is decisively against the theory of emission. [UNDULATORY THEORY.]

The fact that the differently coloured rays have different refractive indices has been thought by some to offer a great difficulty to the undulatory theory, inasmuch as the velocity of propagation within refracting media must depend on the periodic time of the disturbance, which is contrary to the laws of elastic fluids. The circumstances are, however, different, as the fluid in this case envelops the material particles of the medium, instead of constituting one uninterrupted mass. Besides, the fact of dispersion has been accounted for on this theory, and even its law (in the case of substances of low dispersive power) deduced, by adopting certain dynamical hypotheses not improbable in themselves.

If μ be the index of refraction when light passes from vacuum to a medium (A), and μ' when it passes from vacuum to a medium (A′), then $\frac{\mu'}{\mu}$ is the index when the ray is transmitted directly from the former to the latter.

For if we look at a star through a medium bounded by parallel planes, as a plate of glass, its position will not be affected, and therefore the emergent light is parallel to the incident; but since the second angle of incidence is equal to the first angle of refraction by the parallelism of the planes, and the second angle of refraction is equal to the first of incidence by the parallelism of the rays, therefore the index of refraction out of a medium into vacuum is the reciprocal of that from vacuum into the medium. Again, if we place in optical contact two plates of different refracting media A, A′, as for example a horizontal plate of glass covered with water, the emergent light is still parallel to the incident. Now the second angle of incidence or first of refraction is given by the equation $\sin I' = \frac{1}{\mu} . \sin I$; and the second angle of refraction or third of incidence, by the equation $\sin I = \mu' \sin R'$: whence $\sin I' = \frac{\mu'}{\mu} \sin R'$. Hence, generally, if the emergent ray be supposed to become incident, the latter will take the place of the emergent.

This fact shows that the velocity of light which traverses several media is the same as if transmitted directly from vacuum to the last medium, which is consonant to both the theories of light. In the wave theory, the velocity of the waves in a medium is independent of the mode of their propagation, and in that of emission the increment of the square of the velocity generated at one surface of a medium is destroyed by like forces on its emergence at the second, so that the only increment it finally receives is that generated by the surface of the last medium it enters, and which it would receive if it entered this medium directly from vacuum.

The index of refraction is greater than unity from a rarer to a denser medium, and less than unity from a denser to a rarer. Hence in the latter case there is a limit to the angle of incidence, beyond which it is impossible for the ray to emerge into the rarer medium, for since $\sin R = \frac{1}{\mu} \sin I$, it follows that R is a right angle when $\sin I = \mu$, or the emergent ray is then parallel to the surface; but if $\sin I > \mu$, then $\sin R > 1$, which is impossible. Observation shows that the light is then totally reflected.

Let us now trace the progress of a ray passing through a medium terminated by planes inclined at a given angle α, as in the case of light refracted by a glass prism. Let μ, μ' be the indices of refraction into the medium through its first bounding plane, and out of it through the second, and let I, R, be the first angles of incidence and refraction, I′, R′, the second, and D the total deviation, and suppose the plane of incidence to be perpendicular to both planes, so that there may be no deviation in planes; the following equations fully describe the progress of the ray: $\sin I = \mu \sin R$; $\sin I' = \mu' \sin R'$; $\alpha = R + I'$; $D = R' + I - \alpha$: thus I being given, the first equation determines R, the third I′, the second R′, the fourth D.

When the deviation is a minimum we have $\frac{dR'}{dI} = -1$, and generally $-\frac{dI'}{dI} = \frac{dR}{dI}$; and by differentiating the other equations we have

$$\cos I = \mu \cos R . \frac{dR}{dI}; \cos I' . \frac{dR}{dI} = \mu' \cos R';$$

therefore $\cos I \cos I' = \mu \mu' \cos R \cos R'$

by squaring $(1-\sin^2 I)(1-\mu'^2 \sin^2 R') = \mu'^2 (\mu^2 - \sin^2 I)(1 - \sin^2 R')$;

$$\text{or if } m = \frac{1}{\mu'} \text{ then } (m^2-1) \cos^2 I = (\mu^2-1) \cos^2 R'$$

$$\text{and } \left(1-\frac{1}{m^2}\right) \cos^2 R = \left(1-\frac{1}{\mu^2}\right) \cos^2 I'.$$

When the ray after the second refraction moves in the same medium as before the first incidence, we find the minimum deviation when $I=R'$ and $R=I'$; the internal part of the ray is then equally inclined to both planes. We have then $R=\frac{a}{2}$, $I=\frac{D+a}{2}$, $\mu=\frac{\sin\frac{1}{2}(D+a)}{\sin\frac{1}{2}a}$, which affords a simple method of determining the index of refraction of media capable of being formed into prisms.

When light emanating from one point is refracted accurately to another, if r, r' represent the incident and refracted rays, and s an arc of the curve by the revolution of which the refracting surface is generated, $\frac{dr}{ds}$, $\frac{dr'}{ds}$ are the sines of the angles of incidence and refraction (abstracting from their algebraical signs), therefore $\frac{dr}{ds}\pm\mu\frac{dr'}{ds}=0$ and $r\pm\mu r'=\text{const.}$: this equation belongs generally to a curve of the fourth order, but if r be infinite, or the incident light parallel to the axis, it gives a conic section, and if the arbitrary constant vanishes the equation $r=\mu r'$ represents a circle. If one surface be given, it is easy to find a second by which homogeneous light may be refracted accurately to a given point.

When light is incident on the generality of crystallised bodies, the ray is refracted in two directions, one of which in uniaxal crystals obeys the ordinary law of refraction, but neither in biaxal crystals. On the theory of emission the forces cannot here be simply normal to the faces of the crystals, but have a connection with the directions of the axes of crystallisation, while on that of undulation the inertia of the ether within such bodies, or else its elasticity, is different in different directions, and the form of the wave-surface ceases to be spherical. The further consideration of that subject will be resumed in the article Polarisation of Light.

The formation of foci and images by reflection and refraction follows from the simple laws here discussed, for an account of which the reader may refer to Optics; the description of the instruments constructed to take advantage of the properties of light being given in Lens; Microscope; Mirror; Optics, Practical; Telescope.

The laws of the reflection and refraction of light admit, as we have seen, of being satisfactorily explained according to either of the two theories respecting which the scientific world was once divided. But while the undulatory theory explains the interference of light, and traces into their most minute details the curious and complicated phenomena of diffraction, no satisfactory account has ever been given of these phenomena on the theory of emission. The remarkable phenomena of polarisation again, so difficult to conceive on the theory of emission, fall simply and naturally into their places on the theory of undulations, when once the doctrine of transversal vibrations is admitted. And even to go no farther than the laws of reflection and refraction, which entail the necessity of making opposite suppositions, on the two theories, respecting the velocity of light within refracting media, the crucial experiment of M. Foucault's already alluded to ('Annales de Chimie,' § 3, tom. 41, p. 129) is decisively in favour of the theory of undulations.

It must be confessed that there is one phenomenon, perfectly simple according to the theory of emission, which presents a serious difficulty on the theory of undulations, namely, the astronomical phenomenon of aberration, according to which a star appears displaced from its true position, in a direction towards the point towards which the earth is moving, by a small angle measured by the ratio of the velocity of the earth to the velocity of light, multiplied by the sine of the angle between two lines, drawn, one in the direction of the earth's motion, the other from the earth to the star. The common explanation of this phenomenon involves the tacit assumption that the rectilinear propagation of light is not affected by the motion of the earth. We might have expected beforehand that, just as a ship in moving through the water would disturb in its neighbourhood the course of little ripples with which the surface might be covered, so the earth in moving round the sun would push the ether out of its way, and thus disturb the course of progress of the little tremors of which light consists. To get rid of this difficulty, many adopt Dr. Young's supposition, that the earth allows the ether to pass freely through it as the wind does through a grove of trees. The rectilinear propagation of light, and consequently the phenomenon of aberration, is however explicable without making this rather startling supposition, by supposing the motion of the ether consequent upon the motion of the earth to be of a particular kind. See several articles in the 'Philosophical Magazine,' 3rd series, vols. 27 to 32.

The production of *colours* by ordinary refraction is considered in the articles Dispersion and Rainbow; for that produced by light passing near the edges of bodies, and by interference, the reader may consult Diffraction and Interference. For the colours of plates, see Undulatory Theory.

LIGHT, ABSORPTION OF. [Absorption of Light.]

LIGHT-BALLS, for military purposes, are hollow cases, either spherical or in the form of cylinders, terminated at each extremity by a hemisphere: they are filled with a combustible compostion, and being thrown, by night, in a burning state from mortars, or in some cases from the hand, they serve to discover the working-parties or troops of the enemy.

The spherical cases are made of canvas or cartridge-paper, cut into eight equal gores of a proper form and the edges sewn together, a hole being left for the introduction of the composition and the application of a fuze. The oblong cases consist, frequently, of two hollow hemispheres of iron, which are connected with each other by four slender bars of iron attached to their bases, in positions parallel to the axis of the case, and the whole is then covered with canvas: the entire length is about 1½ calibre of the piece of ordnance from which the ball is to be projected,—a mortar of one of the four different kinds, the calibre varying from 4⅖ inches to 10 inches.

The composition consists of pulverised saltpetre (6¼ lbs.), pulverised rosin (1¾ lbs.), ground sulphur (2¼ lbs.), and linseed oil (¼ lb.). The dry materials, after having been passed through a sieve, are mixed with the oil while the latter is in a boiling state; and sometimes a small quantity of mealed gunpowder is added. The oblong balls are filled by passing the composition through a fuse-hole in one of the hemispheres and are afterwards strengthened by cord wound about them. The fire is communicated to either kind of ball, at the time of being projected, by means of a piece of quick-match in the fuse.

Previously to besieging a fortified place, the works and the ground about them are reconnoitred, usually by night; the first trenches are also traced and formed during the hours of darkness, and therefore the defenders, at the commencement of the siege, prepare some mortars charged with light-balls: these balls being thrown beyond the glacis, enable them to discover the operations of the enemy, and direct a fire of shot against them. The assault of a breach is also frequently made by night; and in this case light-balls are thrown by the defenders into the ditches of the place for the same purpose. These may be made by merely filling grenades with the composition above mentioned, and they may be thrown by hand.

Major-General Sir J. T. Jones states ('Journal of Sieges') that the defenders of the towns which were besieged by the British army in Spain threw light-balls in order to discover the operations of the attack; and that two or three men of the engineers' brigade were kept in readiness to run up and extinguish them as they fell. That officer adds that the men generally succeeded, in a few seconds, in smothering them with filled sand-bags, or by shovelling earth over them. Some casualties are stated to have occurred among the men so employed, but the fire of the enemy being directed against them was thereby diverted from the working-party often employed at only a few yards' distance from the ball. On account of the great utility of such balls for illuminating the ground occupied by the enemy, Sir J. T. Jones recommended that grenades or other missiles should be connected with them by pieces of chain, in order that, through the risk of the explosion, men might be deterred from attempting to extinguish the light.

It may be added here that spherical cases of pasteboard or canvas filled with a composition which while burning emits a great quantity of smoke, are frequently discharged from mortars in order to conceal a movement of troops from the view of the enemy: they are also occasionally thrown from the hand either to suffocate the men employed in the galleries of military mines or to compel them to quit their work: these are called smoke-balls. The composition consists of mealed powder (5 lb.), pulverised saltpetre (1 lb.), pulverised seacoal (1½ lb.), pitch (2 lb.), and tallow (¼ lb.): the pitch and tallow are melted together, and the dry materials, after being sifted, are mixed with the liquid.

LIGHT, BAROMETRIC. [Barometer.]

LIGHT, CHEMICAL ACTION OF. [Chemical Affinity; Light, Photography.]

LIGHT-EQUATION. In consequence of the time employed by light to traverse the solar system, phenomena are not seen at the exact moment of their happening. The first step in astronomical prediction is the finding the absolute moment of time at which a phenomenon occurs; the next is to apply a correction which gives the time at which it is seen at the place for which the prediction is made. This correction or equation is called the light-equation. This term is however principally applied to the correction which is necessary in the case of eclipses of Jupiter's satellites.

LIGHTHOUSES and DUES. [Trinity House.]

LIGHTNING. The general circumstances attendant on a thunderstorm are familiar to most persons. It will however be useful to state some of the most prominent, with a view to their explanation when regarded as electrical phenomena.

At first we see light clouds forming with jagged edges, the relative motions of which are frequently opposite and variable. The atmosphere at the surface of the earth enjoys a stillness and calm, accompanied with some elevation of temperature, as well as considerable barometric and hygrometric changes, which produce on the animal system the sensations of closeness, faintness, and oppression, and appear even to the brute creation indicative of some awful and impending changes. Some of these light clouds appear stationary, as if the forces which produced contrary motions in the others made an equilibrium in these. A low murmuring and continued sound of distant thunder is soon heard, after which the lower region of the air is refreshed with cooler but light breezes of uncertain direction. The calm is resumed, but the thunder-clouds are nearer, apparently larger, and much blacker, and their influence on the nervous system is felt by an indescribable sensation of uneasiness. Lightning flashes are now perceived at short intervals; their course is sometimes zigzag, when it is called *forked* lightning; the aberrations in its course show that it is near terrestrial objects, and is therefore justly regarded as dangerous. In a few seconds after the discharge, heavy showers of rain or hail descend, and the atmosphere is again cooled. The blackness now becomes universal; the thunder, which before roared continuously and at a sensible interval after the discharge of the lightning, is now heard in a loud and sudden clap almost at the same instant that the lightning is seen descending towards the earth with immense velocity, and resembling a globe of flame.

These phenomena are the most common concomitants of thunder-storms, particularly in summer time. But storms are also produced by rapid changes in the atmospheric currents, for instance when the equinoctial gales usually set in; or, as met with in violent and destructive gales, as in crossing the Atlantic with both a revolving and progressive movement, and becoming mixed with various strata of the air through the regions which they traverse, accompanied in several places by destructive thunder-storms.

The colour of the lightning is generally a variable yellow, but it may also be red, blue, or violet, depending much on the density and composition of the strata of air through which the discharge takes place.

In 1752, Franklin in America, and Dalibard in France, commenced, independently of each other, a series of experiments tending to identify lightning with the discharge of ordinary electricity. [ELECTRICITY, ATMOSPHERIC.] Their identity might well be suspected from the number of analogies known to exist between them. For example, the zigzag path of the electric spark from the prime conductor of an electrical machine to a conductor held within striking distance of it resembles on a small scale the course of forked lightning; both are drawn off by pointed bodies in preference to others, and lightning also prefers, *cæteris paribus*, the best electrical conductors: both can fuse metals and inflame combustibles, destroy sight and animal life, magnetise steel and reverse the poles of a magnet.

Franklin, in June, 1752, perceiving a thunder-cloud approaching, sent up a silk kite attached to a dry hempen cord. The loose threads of the cord stood erect, and upon pointing his finger to the cord, he drew sparks. When in consequence of a little rain the hempen cord became a better conductor, the supply of electricity from the cloud became more copious, and by the smartness of the shock ensuing, the danger of prolonging the experiment was sufficiently indicated.

A similar result had already been obtained in France a month earlier, by Messrs. Dalibard and Delor, acting however in obedience to the instructions sent to Europe by Franklin, in 1749. Atmospheric electricity became a favourite study now that the identity between lightning and ordinary electricity was established. It received a check however in consequence of an accident to Professor Richmann, of St. Petersburg, who having attached a simple species of electrometer to his apparatus for measuring the electric intensity of a thunder-cloud, proceeded, immediately after a loud clap, to read off the indication of his instrument, when a globe of electric fire was discharged through his body, and he fell instantly dead. This was on the 6th August, 1753.

Some of the causes which produce atmospheric electricity are stated under ELECTRICITY, ATMOSPHERIC. It will there be seen that the atmosphere is nearly always in a different electrical condition to the earth, the one being usually charged with positive electricity and the surface of the earth with negative. It was shown also that the electrical intensity increases with the height, that in stormy weather, in rain, hail, or snow, the electricity of the air is much more intense than at other times, and is liable to sudden changes from + to — and from — to +. Now the effect of heat, evaporation, and other causes, is to exalt the electrical condition of the air, while a surface of cloud acts strongly by induction upon another opposed surface of cloud, or upon the opposed surface of the earth beneath, and the two opposed surfaces mutually reinforce each other. The cloud and the earth may thus be regarded as the terminal planes of a highly charged system of dielectric air, the tension of which goes on increasing until any further increase causes it to break down, when the opposite electricities rush together with violence, producing what is called a *disruptive discharge*, or in other words a flash of lightning, accompanied by thunder. During a thunder-storm the air between these two terminal planes may be charged and discharged a number of times until equilibrium is attained, or until the thunder-clouds are borne away by the wind to another locality.

There are various kinds of lightning, presenting different phenomena, and recognised under different names. In the first place there are those narrow well-defined ribbons or lines of light, moving in a zigzag course, of a dazzling white colour, but sometimes of a violet or purple hue; these form, probably, the only kind of lightning that strikes terrestial objects. It proceeds from a single point, and frequently divides into two or more distinct streams. It is this bifurcation, or trifurcation, that has obtained for it the name of *forked lightning*. When forming a long rippling line of light, sailors call it *chain lightning*. Some admirable illustrations of this, the first kind of lightning, are given under BREATH FIGURES. When the lightning appears to be spread over an extensive surface, and varies in colour, being often red, but sometimes blue and violet, often confined to the edges of clouds, but when apparently issuing from the interior, the clouds are said to *open*, we have the variety known as *sheet lightning*. Lightning of this kind when unaccompanied by thunder is known as *summer lightning*, and is the reflection in the upper regions of the atmosphere of common lightning, having its origin in a storm, the direct view of which is obstructed by the rotundity of the earth. A third kind of lightning is the *globular*, which appears like a luminous ball or globe of fire; it moves through the air at a comparatively slow rate, while lightnings of the first and second class exist but for a moment. Lightning of this kind sometimes obtains the name of *fire-balls*: it rolls along the surface with a hissing noise, and often terminates in a disruptive discharge. This kind probably arises from a kind of glow or brush discharge in certain points of an excited system of air, preparatory to the more general and rapid union of the electrical forces. A milder form of this variety of lightning is known as *St. Elmo's* or *St. Helmo's* fire to the French and Spaniards, the *fires* of *St. Peter* and *St. Nicholas* to the Italians, while the Portuguese call it *Corpos Santos*, which our English sailors seem to have corrupted into *Comazants*. It appears as tufts of light upon the points of ships' masts, the tips of spears, bayonets; on the alpenstocks of Alpine travellers, on the tips of the fingers when the outspread hand is raised, and on any other pointed bodies, during a peculiarly excited state of the atmosphere, when the particles of air near the bodies in question discharge themselves upon the particles immediately above them, the electrical condition of which is less intense, the effect being a luminous brush of light, accompanied by a slight roaring noise. This *brush discharge* is, in the language of that excellent electrician Sir W. Snow Harris, "an intermitting series of electrical sparks between metal and air, but in such rapid succession as to convey the idea of a continuous stream." In some cases the appearance of the *brush* is changed into that of a *star*, as when proceeding from negative or resinous electricity, when the discharge is *towards* the pointed conductor, and not *from* it as in the case of the brush discharge. A kind of *brush* discharge usually precedes the discharge of a Leyden jar, or of a thunder-cloud upon a ship or building, marking out, as it were, the line of least resistance for the principal discharge. [BREATH FIGURES.]

When lightning strikes the earth the resulting effects are of the most varied character. It is a popular remark that the lightning-stroke is succeeded by a suffocating odour, which has been compared to that of burning sulphur. Scientific chemists have compared it to the odour of phosphorus, or to that of nitrous acid; but it is more than probable that this odour is due to the presence of OZONE, which is probably generated by the action of lightning on the oxygen of the air. The passage of lightning through the air causes a combination of its constituent oxygen and nitrogen in the proportions to form nitric acid (NO_5). It was shown by Cavendish that by passing artificial electrical discharges through a confined portion of air this acid was formed. Liebig has also shown that in seventeen specimens of rain-water, collected during or immediately after thunder-storms, all contained nitric acid in greater or less quantities in combination with lime or with ammonia, while out of sixty specimens collected during ordinary rains, these substances were not found in fifty-eight of them. The formation of ammonia (NH_3) during thunder-storms shows that lightning decomposes a portion of water. The presence of ammoniacal salts in storm rains is of great importance to vegetation, while the nitric acid of the storm is probably one of the sources of the natural nitres of the earth.

The fusion of metals is one of the commonest effects of lightning. There are instances of an iron chain being traversed by the lightning, the effect of which was to soften the links so that they united by their own weight, and the chain was converted into a rod of iron. Franklin relates the case of a church struck by lightning, which passed along an iron wire 20 feet long, and about the thickness of a knitting-needle, and dissipated it in smoke, leaving a black trail behind. There are cases also of the discharge passing down bell-wires, destroying them entirely, and leaving the oxides resulting from the combustion impressed upon the walls of the room in broad bands. A year or two ago, a house at Paris was struck; the lightning broke several panes of glass in a shop front, and burnt away the gilt letters of the word *Café*. In all cases of this kind the conductor is not of sufficient capacity to transmit the discharge, so that the lightning being delayed in its progress, its astonishing heating power becomes developed, and the result is the fusion and oxidation of the metal. According to Harris, a copper rod three-quarters of an inch in diameter, or an equal quantity of copper under any other form, is sufficient to withstand the heating effect of any discharge of lightning of which the effects have ever been recorded. The wonderful heating effects of lightning are manifested in the formation of *vitrifications* and *lightning tubes*, also known as *fulgurites*. [FULGURITE, in NAT. HIST. DIV.] These are long, irregular, cylindrical bodies of sand, or other siliceous material, fused into a kind of glass or enamel, and appear to have been formed by the lightning striking and penetrating the rock, and fusing the loose materials together. The outer surface of the tube is often rough and uneven, and deeply furrowed, while the interior may be formed of whitish or limpid vitrified matter covered with a smooth glaze, and hard enough to scratch glass.

When lightning strikes solid imperfect conductors, it tears them to pieces, and scatters their fragments to great distances, just as if a powerful explosive force had been suddenly generated within them. Thus churches unprovided with lightning-conductors have had their steeples and towers destroyed, and heavy stones projected in all directions, to a distance of several hundred yards, while timber and growing trees are torn into shreds, as if from the operation of some powerful internal force, which Arago is disposed to attribute to high-pressure steam, generated by the intense heat of the discharge acting on the sap of the wood. The masts of ships have in like manner been reduced to fragments in a moment. Thus, the log of the *Rodney*, struck by lightning in December, 1838, records the following effects:—The top-gallant and royal-mast, 53 feet long, weighing nearly 8 cwt., entirely disappeared from the ship, with the exception of the end of the royal-mast. The sea was covered with chips and splinters, and "the water alongside looked as if it had received all the refuse of a carpenter's shop." Out of twenty-six immense iron hoops, which were clasped or driven round the mainmast, thirteen were broken asunder, and came rattling down on the deck with a horrid clang; the ravages of the discharge could be traced through 53 feet. The lightning had entered the very heart of the mast, which it charred, and at the point where the lightning escaped was a hole many inches deep. Cases of this kind are very numerous, and are all marked by somewhat similar effects, where the lightning has to encounter a mixed system of good and bad conductors, such as the wood and metal work of a ship, or the stone and metal work of a church-steeple. The lightning will pick out these masses of metal as so many points in the line of least resistance, and in order to get at them, will rend and disperse badly conducting materials; in short, by its behaviour, it so clearly pointed out the remedy to be adopted, namely, that of furnishing a sufficiently capacious line of conduction from the highest points of the ship or building to the earth, that we can only wonder at the blindness of architects and engineers in not adopting the remedy; but most of all are we surprised at the opposition which survived until quite recently at the proposition to supply every ship in her Majesty's Navy with the fixed system of conductors which will be more particularly noticed in the next article.

A very common result of an explosive discharge of lightning, especially in a ship not furnished with proper conductors, is to disturb, weaken, or destroy the magnetism of the compass-needle, or to reverse its poles, to render masses of iron and steel strongly magnetic, even to the steel parts of mathematical instruments and the springs of watches and chronometers. Cases of this kind are constantly occurring, and we need hardly point out the danger to a ship out at sea, with an impaired compass and chronometer. [LOCAL ATTRACTION.]

The action of lightning is every year fatal to man and beast, as well as destructive to property. M. Boudin, in an elaborate work on the subject, has shown that from the year 1835 to 1852, as many as 1308 persons had been killed by lightning in France, which gives an average of six persons every month, and this statement does not include those struck by lightning, but not killed. Out of an annual number of 103, the largest number of deaths is in June, in which there are 22, and in August 19; no deaths from this cause occur during November and the three following months. The number of persons killed every year by lightning is stated on an average to be, 22 for England, 21·83 for the United States, and 9·64 for Sweden. The mortality from lightning among the lower animals appears to be more extensive than among human beings, probably from their being congregated together in larger numbers. Thus we read of 2000 sheep being killed by a single flash of lightning. This occurred in Ethiopia, and is given on the authority of M. D'Abbadie. At Sacco, in the kingdom of Naples, in August, 1858, the lightning killed 120 sheep, out of a flock of 140. Neither the shepherd nor the shepherd-boy was hurt, but a kid which the latter held in his arms was killed. Cases of this kind are not uncommon, in which the shepherd and the huntsman have been spared, while the sheep, the dogs, and the horses have been struck.

Accidents from lightning are more frequent on elevated places than in the plains, and in a village or the open country than in the crowded city. Some of the most disastrous accidents from lightning have proceeded from the explosions of magazines of gunpowder. Large portions of cities have been destroyed from this cause, such as Brescia, in 1769; Malaga, in 1780; Luxembourg, in 1807; Navarin, in 1829; Gaucin, in Spain, in 1843: and many other places down to our own time. The damage to shipping we have already referred to. But we may just glance at a parliamentary paper, belonging to the session of the House of Commons for 1854, consisting of a list of 280 ships of the Royal Navy, damaged by lightning between the years 1790 and 1840. These cases include 106 ships of the line, 70 frigates, 80 sloops and brigs, 2 schooners, 7 cutters, 5 sheer hulks, 5 ships in ordinary, 5 steamers, 2 of which were of iron, so that every variety of vessel has been attacked by lightning. In these cases there were damaged or destroyed 185 lower masts, of which 135 belonged to line-of-battle frigates; not less than 100 were completely ruined; 180 topmasts were ruined or damaged, 150 top-gallant masts destroyed, including of course large quantities of rigging, sails, and other stores. In about one-eighth of these cases the ships were set on fire by the lightning, either in the masts or in the sails, or rigging, and in some cases the ships were severely damaged in the hull. Of course the men on board did not always escape. Nearly 100 seamen were killed, and upwards of 250 dangerously hurt.

Protection from lightning has occupied the attention of persons in all ages, and has led to many superstitious practices. The ancients believed that lightning never struck deeper into the earth than five feet, so that caverns were favourite places of resort during thunder storms. A grotto containing a reservoir of water has also been a favourite place of retreat. The Romans fancied that seal's skin was a preservative against lightning, and tents were constructed of this material as a retreat for persons during a storm. In the Cévennes, the shepherds to this day wear the skins of snakes in their hats as a preservative against lightning. The ringing of church-bells during a storm is a custom still practised in Roman Catholic countries, under the idea of dispersing the storm: indeed, this is one of the functions assigned to the bell in its baptism. The kindling of large fires in the open air, and the firing of cannon, may also be reckoned among the puny efforts which ignorance sometimes directs against one of the grandest powers of nature. It has been supposed that certain trees are never struck by lightning, and the question is even debated at the present day, as to what trees are most liable to be struck. It is also a favourite opinion that persons in bed have nothing to fear from lightning, and this is to a great extent true, although there are cases of persons having been killed by lightning while in bed. Glass being a non-conductor, it was ignorantly supposed that it would repel lightning, and it was customary to place a thick ball of glass on the projecting points of buildings, ships, and lighthouses. The spire of Christ Church, Doncaster, thus furnished, was destroyed by lightning in November, 1836. Chambers constructed wholly of glass have been made for the use of timid persons during a thunder storm; a useless precaution, since there are cases of glass windows being struck by lightning and the glass reduced to powder.

When lightning strikes persons it particularly attacks any metal which they may be wearing at the time. In July, 1858, a peasant woman near Auxonne in France, returning with her husband from the fields, was struck dead by lightning; her hair was singed, and part of a silver comb melted; the husband escaped with only a slight shock. There are many such cases, where the bracelet, the wire of a bonnet, the watch, &c., have been struck, and even fused without loss of life. Men and animals in a line, as soldiers in a regiment or horses in a stable, are liable to danger at or near the extremities of the line rather than in the centre. There are cases on record of the first and last horse, or the first and last children sitting on a bench, having been killed, while the intermediate individuals escaped. It is difficult to account for cases like these, but probably there are variations in the state of the skin as to moisture or dryness, articles worn about the person, the kind of dress, &c., all very difficult to trace, but which may have some effect in determining the course of the discharge. Franklin advises timid persons, occupying houses which are unprotected by lightning conductors, to avoid the neighbourhood of chimneys during a storm, because the soot is a conductor of electricity. Also to keep as far away as possible from metals, mirrors, and gilded articles. The best place is in the middle of the room, provided there is no lamp hanging from the ceiling. A person is less exposed by avoiding contact with the walls and the floor, and hence the safest of all expedients is to go into a hammock suspended by silken cords in the centre of a large room. If this cannot be done, it is advisable to place between the person and the floor some badly conducting substance, such as a mattress. In short, the position of safety is that in which the body cannot assist as a conductor to the passage of the lightning.

What is called the *return stroke*, is when the electricity of a cloud strikes the earth, and then bounds up again to another cloud. There are many other minute phenomena connected with lightning which are deserving the notice of the student. The subject is treated with great minuteness in Arago's notice 'Sur le Tonnerre,' published in the 'Annuaire du Bureau des Longitudes,' Paris, 1837. Sir W. Snow Harris has also a work 'On the nature of Thunderstorms,' 1843. De la Rive's large work on Electricity also treats on the subject; but perhaps the most accessible book specially devoted to the phenomena of thunderstorms, is by C. Tomlinson, entitled 'The Thunderstorm; an account of the properties of Lightning, and of Atmospheric Electricity in various parts of the World,' published in 1859.

For some notice of the accompaniment of lightning, see THUNDER.

LIGHTNING CONDUCTOR, is a bar of metal, or system of bars of metal, attached in a particular manner to a building or a ship, and extending from below the level of the ground, or from the ship's metallic sheathing, to a point or points several feet above the highest parts of the roof, or of the steeple, if the building have one, or the ship's masts, in order to secure the edifice from the effects of lightning: the upper extremity of the rod or bar should terminate in a point.

From the time when the identity of lightning and electricity was established, a great deal of misapprehension has existed, and continued even to our own day, as to the proper function of a lightning conductor. We have seen it stated by persons calling themselves architects and engineers, as well as by persons holding high official rank, that lightning conductors do more harm than good; that they invite the lightning to the building or ship; that they are a needless expense, and so on: and hence we see new churches built every year without lightning conductors, and every year we read of steeples being knocked down, and churches damaged, or set on fire by lightning; merchant-ships are also sent to sea without conductors, and are sometimes lost or disabled as a consequence of the neglect.

The amount of misapprehension on this subject would form a long history if properly brought together. Soon after the first employment of lightning conductors in Europe, an opinion prevailed that when their extremities were pointed they created a danger which did not exist before, and that they attracted lightnings which would, without the rods, have discharged themselves at a distance; and in order to diminish the risk, it was proposed to crown the summits of the rods with knobs or balls of metal. This notion was entertained by the Abbé Nollet, in France; but in the Royal Society of London the question concerning the relative efficacies of pointed and knobbed conductors was agitated with great vehemence, chiefly through the obstinacy of Mr. Wilson, one of the Fellows, who, in 1778, made himself the head of a party in support of the latter kind of conductors, in opposition to the president. [PRINGLE, JOHN, in BIOG. DIV.] It is remarkable that both George III. of England and Frederick of Prussia placed themselves on the side of the opponents of Franklin; the first king giving the preference to balls over points; and the other, while he consented to have conductors raised on his barracks and powder-magazines, prohibited the erection of them on his palace of Sans Souci. It is now admitted that the prejudice against pointed lightning conductors was entirely without foundation: those conductors have been found not only to protect buildings when struck, but also to diminish the number of shocks which in a given time they have experienced. An experiment which was made by Beccaria, in 1753, might have shown the superiority of pointed conductors over those with balls; for that distinguished electrician set up on the roof of the church of San Giovanni, at Turin, a metallic-rod bent near the top and terminating in a point: the upper part was capable of being turned round by means of a silk line, so that the point could be directed upwards or downwards at pleasure, and the lower part of the rod terminated upon substances which were imperfect conductors of electricity. On directing the point towards the sky when a thunder-cloud passed over the church, electrical sparks issued in abundance from the foot of the rod; but when the point of the rod was reversed so that the bend was upwards, few or none were obtained. The conducting-rod set up by Professor Richmann, at St. Petersburg, may be said to have been the cause of his death (in 1753); but the house would most probably have been struck if there had been no conductor. The immediate cause of the melancholy accident was that the rod led into the apartment, and the unfortunate professor was standing too near its lower extremity. ('Phil. Trans.,' vol. xlviii.)

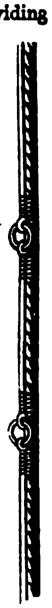
There has also been much discussion concerning the distance to which the protecting influence of the rod extends; *the radius of protection*, as it is called: the French electricians have even gone so far as to define it. According to them, this influence is limited by the circumference of a circle described about the rod with a radius equal to double its height above the top of the building. It will be seen presently that there is no ground for this assumption.

The conditions under which a lightning conductor protects a building not being understood, faults of construction have frequently occurred, and buildings and ships armed with inefficient conductors have more than once been struck. Thus in 1777 the magazine at Purfleet was struck by lightning: the shock took place on an iron cramp which united two stones of the cornice, at the distance of 24 feet from the lightning conductor, measured horizontally; and the upper extremity of the rod was 11 feet above the top of the roof on which it was erected. Again, in 1781, the workhouse at Heckingham in Norfolk, though provided with eight rods, was struck by lightning at a spot which was distant 55 feet measured horizontally from the nearest rod, while the pointed summit of the latter was 22 feet above the level of the part struck; and many other instances might be cited. So, also, the most elevated objects are not always those which are struck by lightning; for in 1829, the sails of a mill at Toothill, in Essex, being at rest, the electric fluid left untouched the arm which was in a vertical position, and fell on a knob of iron at the middle of one of those which was inclined to the horizon in an angle of 45°; and it has frequently happened that buildings containing in their walls conducting substances have been struck much below their summits by a lateral action of the fluid; bars or plates of metal in the side walls having served to assist its progress to the earth better than the materials on the roof. This happened to the cathedral at Lausanne in 1783.

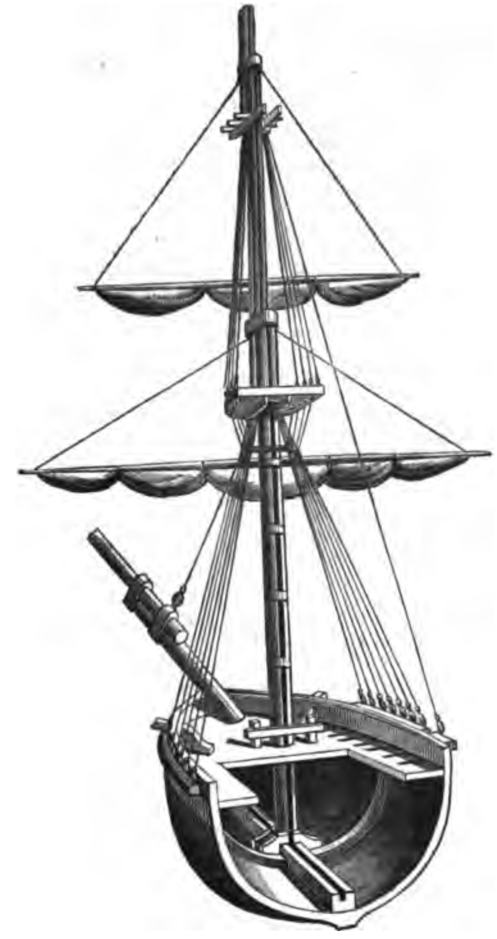
Now what is the action of a lightning conductor? We have seen in the previous article that the general conditions of a thunder-storm consist in the charging and discharging of a stratum of air situated between a mass of clouds and the earth beneath, which are in opposite electrical states. Now, it will be evident that any artificial elevation on the earth's surface, such as a church on land or a ship at sea, is, with respect to a thunder-storm, a mere point in the lower terminating plane of the great electrical disturbance. The electrical forces cannot be supposed to operate exclusively between such an elevation and a charged cloud. The building or the ship is a mass of matter accidentally placed in a position favourable for the union of the two opposite electricities in a given direction. Electrical discharge always takes place on those bodies which tend to assist its progress. If a church or a ship happen to form part of the line of least resistance, the lightning will pass down that line, and if any damage is done, it is because the structure is made up of good and bad conductors; and the remedy is, to connect all the good conductors into one uniform system of conduction, so that the lightning, wherever it may happen to strike, may find an easy passage to the earth or the sea.

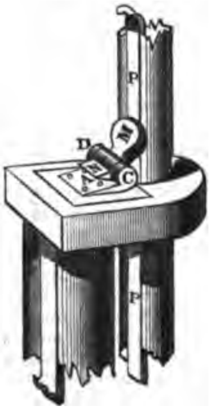
Hence, then, it is not in general sufficient to erect a rod above the highest point of the building and lead it in a vertical line down to the ground; but it is necessary in an extensive building to connect all the masses of metal, roof-coverings, water-pipes, clamps, &c., into one consistent conducting system; and, more than this, if several points of the building project into the air, each point should have its appropriate lightning-rod. Thus, in a three-masted ship, it is not sufficient to furnish the main-mast with a conductor; for cases are on record of the lightning striking and damaging one of the other masts, which was unprotected, and taking no notice of the protected main-mast. We must, therefore, dismiss from our minds all notions of the radius of protection. A lightning conductor only protects the part to which it is applied, and those parts with which it is in metallic connection; and even this protection will fail unless the rod be of sufficient capacity to carry the heaviest discharge of lightning that ever occurs. The metal must, moreover, be a good conductor even among metals; it must be uninterrupted by any breaks or solutions of continuity, and terminate in the earth where the soil is sufficiently damp to serve as a conductor; for if the ground be very dry it may serve as an insulator, and render the conductor comparatively useless. We must also get rid of the notion that the conductor *attracts* the lightning to the building or the ship. It is a line of least resistance; the lightning passes down it because it can do so more easily by that route than by any other; the conductor is, in fact, passive, and has no more voice in the matter than the rain-shoot in discharging the water that pours down it. The more perfect, then, the conductor, the greater is the protection; and this perfection consists in sufficient capacity, good conducting power, and proper distribution over all the parts of the building. Hence chains, and in general wire ropes, should be avoided, as the form interferes with the conducting power; and there are instances of chains and wire ropes being knocked to pieces by the lightning, and the fragments falling on the deck in red-hot rain, and setting the ship on fire.

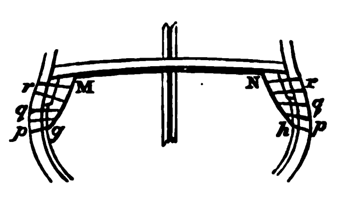
The practical mind of Franklin first suggested the idea of providing buildings with a continued line of conduction for transmitting the electricity to the earth. The first lightning conductor in England was erected in 1762 by Dr. Watson, at Payneshill. In Roman Catholic countries there was some difficulty in introducing the "heretical conductors," as they were called, until the mob was assured that the gilt points placed at the top to prevent corrosion had been blessed by the pope. The first conductor for ships was in the form of chains, consisting of long links of copper rod about a quarter of an inch in diameter, united by small eyes, turned in each extremity; the chain was tied to a rope, and so attached to the mast-head, whence it proceeded over the side of the ship into the sea. Such a conductor would doubtless contribute somewhat to the preservation of a ship, supposing it were in its place during a thunder-storm, and that the lightning struck the mast to which it was applied. The first condition was almost as difficult as the second, for the wisdom of the Admiralty had led to the packing-up of each conductor in a box, to be taken out and used as occasion required. As might be expected, there are cases where a storm has overtaken and damaged a ship before the conductor could be unpacked; and there are other cases in which the lightning has struck and shivered the fore-mast, to which no conductor was applied, while it avoided the protected main-mast; and there is a third set of cases in which the man sent up with a wire rope or chain conductor has been knocked down by the lightning in the act of applying it.



In the year 1821, Sir W. Snow Harris submitted to the Lords of the Admiralty a plan for protecting ships from the ravages of lightning. It consisted in the application of capacious conductors, so permanently fixed as to render them an integral part of the vessel, and independent of the crew under all circumstances. According to this plan, the masts are converted into lightning conductors by incorporating with them a double set of copper plates, so as to produce an elastic metallic line along their surface, capable of resisting any strain which the spars themselves could support, and connecting these plates with bands of copper leading through the side under the deck-beams, and with the large bolts leading through the keels and keelson, and including by other connections all the principal metallic masses employed in the construction of the hull. The accompanying figure shows the line of conduction on the masts, from the vane-spindle to the stem; and these conductors are connected with the hull and with the sea in the following manner: Under the step is placed a double copper conductor, immediately over the heads of a number of the long bolts which pass through the keelson and the keel, so that when the step of the mast is in its place there is a direct metallic communication between the copper bands on the step and the copper outside the ship. Thus there is an extensive capacious conducting-line from the vane-spindle to the sea; and in order to maintain a more complete connection between the different masts at the junction of the caps, a stout copper hinge or tumbler is employed; it is fixed on the cap, and falls against the conductor without being able to turn far back, so that it has just motion enough to follow the yielding or change of the spar. In the figure, A represents the copper plate fixed on the cap, N M an angular plate set on the hinge O D, while P is the conductor on the mast. The transverse conductor, formed of double copper, is secured to the beams, and connected at each side with the iron knees, *g* M *h* N, and the bolts *p q r*, passing through the ship and terminating in the copper sheathing as nearly as possible in the plane of the water-line. The conductors on all the masts, in passing through the ship, are connected with similar transverse bands, led to the side as nearly as possible in the plane of the low water-line. The bands of copper employed for these conductors are 4 feet in length, and vary from 1½ to 5 inches in width, and from ⅛th to 1/16th of an inch in thickness. Holes are drilled in them 6 inches apart, by which they are secured to the masts by short copper nails. The plates are fitted into shallow grooves in the mast, and are inserted in a double series, placed so as to allow the joints of every two plates to fall upon the centre of another plate immediately above or below it. This plan, which is not in any way protected by a patent, is very minutely described in the "Instructions" for the application of Harris's conductor, printed by order of the Lords Commissioners of the Admiralty. After many years of opposition, the plan was at length introduced into H. M. Navy, and its inventor was rewarded with one of the annual pensions granted to distinguished men of science, a parliamentary grant of 4000*l*., and knighthood; a reward by no means excessive, coming as it did in the rear of success, H.M. ships having been struck by lightning in all parts of the world without sustaining any damage; and in some cases the ship has been so severely struck, that she actually "reeled under the force of the discharge" (as the log of one of these ships has it), and, instead of the wreck and devastation which would certainly have followed the absence of conductors, and probably the presence of inefficient ones, no sort of damage occurred.

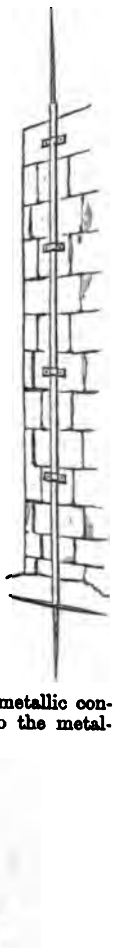


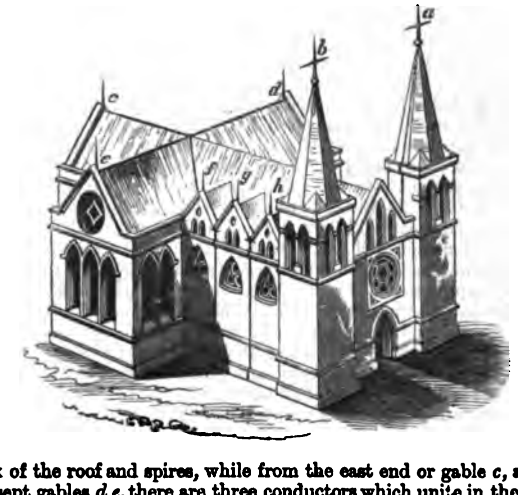




The application of lightning conductors to buildings is guided by the same principles as to ships. All the metal work of the building should be so connected as to render the whole a good conductor, or to throw it into that passive or non-resistant condition, with respect to the electrical discharge, that, when struck at any given point, its lightning conductors would be so capacious that the electricity would have unlimited space for expansion on the surface of the earth in all directions, to which, as we have seen, the charge is determined. Probably the most extensive system of conductors ever erected are those at the new palace at Westminster, on a plan furnished by Sir W. Snow Harris, and described in the 'Estimates, &c., Civil Service, for the year ending March 31, 1856, ordered by the House of Commons to be printed.'

Harris's conductors for buildings consist either of wide bands of copper, or of copper pipes from 1 to 2 inches in diameter, the metal about ⅛th of an inch thick. It is prepared in lengths of about 10 feet, which are united by means of short intermediate pieces furnished with screws. There is a notion among architects that the rod should be insulated, and, accordingly, they attach it to the building by means of rings of glass, forgetting, probably, that when these become wet by the storm they no longer insulate. This is quite unnecessary: the conductor may be supported against the wall by means of coupling-pieces or clamps; the upper extremity should project freely into the air, and should be pointed somewhat like a bayonet, which pointed end may be about 18 inches, ¾ inch diameter, and be screwed into a solid plug fixed into the tubing.* In cases where metallic vane-spindles or other metallic points exist, the rod may commence at once from them. The lower extremity of the rod has three divergent branches, which should pass under the surface of the ground, and if possible be connected with a spring of water, a drain, or some other conducting channel. Should the length of the conductor be considerable, its diameter should be increased. In extensive ranges of buildings the most prominent parts should be furnished with conductors, and be connected by horizontal lines running along the ridges of the roofs, &c. In the accompanying figure the strong black lines represent the metallic conductors, of which there is one to each spire *a b*, leading to the metal-work of the roof and spires, while from the east end or gable *c*, and the transept gables *d e*, there are three conductors which unite in the centre of the roof, from which they descend down one of the valleys to the gutters. There is the same arrangement for the smaller gables *f g h*, where the conductors are connected with the rain-water pipes.





LIGHTS, ANCIENT, are known to the law as the foundation of a right for which a man may prescribe over the premises of another to the unobstructed passage of light in the same degree to which it has theretofore been enjoyed by him or those whom he has succeeded in occupation. The light of day is the property of none, and cannot be granted or acquired in property by any. On the other hand, as he who acquires the fee simple of land has a right extending *ab inferis ad superos*, from the earth's centre to the heights of heaven, he may *prima facie* build as high as he will, and dig as low as he chooses at the very verge of his domains. The user of the surface of his land therefore cannot lawfully be in any other without his consent. But if such a user exist, and is of long standing, it is for the interest of society that individuals who have gradually formed their habits and arrangements, and may have incurred expense, and founded contracts with others in accordance with this privilege of user, should not afterwards be capriciously disturbed therein.

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* It is curious, that at the time we are writing, a committee appointed by the Academy of Sciences at Paris have just issued their 'Rapport sur les pointes de paratonnerres.' It is printed in the 'Annales de Chimie,' 3e serie, tome 43.

It is obvious, that a neighbour's window existing in a wall built to the verge of the adjoining domain, presupposes an access of light to it over the other's land, which he may refuse his consent to, and obstruct by buildings on his own soil. If he do not expressly dissent, and if he do not expressly grant the user for a limited time, and still the user goes on, which is the more common case, the question is whether ever there shall be a time when such user cannot be obstructed. To say that that which began in no right shall by mere length of time become a well established right recognisable in law, is too plainly untenable in point of reasoning to be asserted. Yet the convenience of society required provision to be made for such a result. The judges then, at common law, perceiving this necessity existing not without moral rectitude to justify it, surmounted the difficulty by a fiction; they instructed the jury that from length of uninterrupted user they might presume it to have originated in an unqualified grant of the proprietor and find their verdict in his favour who claimed the continued access of light.

The length of time necessary to justify such a presumption, through uniformity of decision, until it had become a received rule, came to be twenty years. The neighbour's window after so long a time becomes an ancient light. Precision was afterwards given to the practice of the courts under this rule by an Act of Parliament, the 2 & 3 Wm. 4, c. 71, sec. 3 *et seq.*, enacting that after 20 years' uninterrupted enjoyment, the user becomes an indefeasible right, and nothing shall be deemed an interruption to defeat such acquisition of right, unless it has been submitted to or acquiesced in after notice of the act, and of the person authorising it, has reached the person who claims the right.

The right to the free enjoyment of light belongs in the Roman law to the class of Servitutes (easements), among which were the *Servitus altius non tollendi, ne luminibus officiatur, ne prospectui officiatur* ('Dig.' 8, tit. 2, s. 11, 12, 15-17). The general rule is thus expressed by Ulpian : "He who shall attempt to obstruct his neighbour's lights, or to do anything else to damage them, must know that he ought to maintain the form and condition of the ancient edifices. If you and your neighbour cannot agree about the height to which buildings may be raised which you have begun to erect, you will have the privilege of having an arbiter."

The stopping of a prospect is not a nuisance by the law of England, but by the Roman law there was a remedy even in that case, *ne prospectui officiatur*.

LIGHTS, ARTIFICIAL. Most kinds of artificial light, for domestic and manufacturing purposes, are produced by the combustion of coal, solid tallow, liquid oil, or some sort of spirit. One special kind, due to the action of an electric current on charcoal, is described under ELECTRIC LIGHT; another, produced by the action of oxyhydrogen gas on lime, is treated under DRUMMOND LIGHT; a third, of which the peculiarities are due rather to the apparatus than to the combustible substances, noticed under LAMP, SAFETY; while gas-lights are fully treated in the articles GAS, MANUFACTURE OF; and GAS-LIGHTING.

Candles.—These, in the different varieties of dip tallow, moulded tallow, wax, palm oil, composite, stearine, &c., are described in their nature and production under CANDLE MANUFACTURE. We may here simply notice the *Soho* lamp, patented a few years ago, for burning solid tallow or some other kind of fat. The tallow is brought to the form of a long cylinder like a candle without a wick, and is placed in the vertical stem of the lamp; there is a spiral spring beneath it, which presses it up close to a conical cap or cover at the top. A fixed tube passes up through the centre of the cylinder of tallow, from top to bottom; and in this tube is placed a cotton wick dipped in wax, the height of which above the top of the tallow can be regulated by a rack, pinion, and nut. The tallow or fat is made into a hollow cylinder in order to leave room for the central tube containing the wick. When the lamp is to be extinguished, the wick is drawn down below the top of the tube, and again raised before the tallow becomes cold.

One of the projects of this class consists in placing any kind of wax or tallow or fat in a receptacle, having either hot water or hot metal beneath it, so as to keep it in a melted state, fitted to be used in the same manner as oil; but any method of keeping the water or the metal hot would seem likely to be a far greater inconvenience than any supposed good arising from the use of a solid food for the lamp. In another contrivance, however, where the substance employed is either lard or tallow, there is a piece of metal which descends from the flame into the vessel containing the lard; and this metal, becoming heated by the flame, communicates this heat to the lard, and thus keeps it in a melted state. The inconvenience of such arrangements arises from the circumstance that the hot water or a heated piece of metal must be put into the lamp before lighting it, in order to melt the tallow. When this preliminary step is taken, the tallow is kept in a melted state by various means. One ingenious mode consists in having an air-tube within the wick, to carry air up to the flame, and two projections from this tube penetrating into the flame itself; so that the metal of which the tube is made, becoming heated at the upper end, speedily communicates heat to the contents of the lamp below.

Bude Light.—As something intermediate between gas-light and oil-light, we may notice the Bude light, devised and named by Mr. Goldsworthy Gurney. Originally the light was obtained from an oil-lamp, the flame from which was acted on by a current of oxygen gas: subsequently oil-gas was substituted for the liquid oil; but afterwards the gas which is made for lighting the streets of towns was employed to produce the flame, the brilliancy being increased by a current of atmospherical air ingeniously introduced. The apparatus being suspended from the ceiling, the gas, either as it comes from the street or purified by chemical processes, passes up a number of short tubes into concentric annular receivers, the upper surfaces of which are pierced on the whole of their circumference with small holes. On issuing from the perforations the gas is ignited, and thus there are formed as many cylinders of flame as there are rings; while between and around the several cylinders the atmospheric air rises from below to support the combustion. A hollow frustum of a cone, of glass, open at both extremities and having its larger end downwards, surrounds the tubes above mentioned; its lower part resting on the base of the framework within which they are suspended, and its upper part approaching very near the bottom of the flame, so that the atmospheric air in rising is confined between the upper or smaller end of the cone and the flame. The distances between the cone and the rings, and between the rings themselves, are regulated by experiment so that the quantity of air may suffice to bring the temperature of the gas to exactly the degree necessary for causing a separation of the charcoal from the flame, as nearly as possible at the moment that the latter issues from the perforations. The flame from each interior ring serves to augment the heat of that which is on the exterior of it, by which means an increased intensity of light in each is produced; and almost the whole of the light that emanates from the interior rings passes through the flame on its exterior, into the apartment. A cylindrical glass chimney rests at its lower extremity on the margin of a circular aperture in the middle of a circular disk of iron, from 18 inches to 2 feet in diameter, the under surface of which serves as a reflector: this disk, and with it the chimney, is capable of being raised or lowered, by means of adjusting screws, till it conceals the upper extremities of the flame; and thus the latter presents the appearance of a brilliant zone of white light, which is from 3 inches to 6 inches high, according to the pressure of the gas. An apparatus of this kind supersedes the employment of many separate lamps; and, being placed at a considerable height from the floor, it is possible to apply above the glass chimney a pipe which, while it conveys the impure products of combustion through the ceiling, may serve to ventilate the building or apartment. This is found to be a cheap mode of producing a bright light; but as a similar effect may be produced by other means, the distinctive name of Bude light is not now much employed.

Oil Lamps.—The general character of oil lamps is described under ARGAND LAMP. We shall advert here to a few special matters.

One of the difficulties which have lessened the usefulness of common oil-lamps is the tendency of the oil to thicken in cold weather; while another lies in the imperfection of the means for keeping the wick well moistened with oil up to the verge of the flame. Both of these matters have engaged attention within the last few years. The mechanical or *Carcel* lamp, so generally used by the opulent families in Paris, has an apparatus by which the oil is raised through tubes by clockwork, so as continually to overflow at the bottom of the burning wick; thus keeping it thoroughly soaked, while the excess of the oil drops back into the cistern below. Less mechanical and more effective is the *Moderator* lamp, a later invention than the Carcel. The *Meteor* lamp, having some of the properties of the Carcel, is intended to burn rape-oil. The internal arrangements of this lamp are curious and complicated. The lower part of the pedestal consists of a reservoir for containing the oil; and in this reservoir is a kind of piston or plunger, worked up and down by a nut and screw from the outside; the rising of this piston occasions the pressure or tightening of a coiled spring, and this pressure causes the oil to be forced up a central tube towards the flame.

One of the modes adopted for maintaining the oil in a liquid state, is by the use of a lamp constructed by Mr. Parker, in which the oil is used in a hot state. At a small distance around the tube which contains the wick is another tube; and the space between the two tubes, of capacity sufficient to hold a pint, constitutes the reservoir for the oil. The oil is thus so near the flame, that it speedily becomes warm, by which its facility of burning is much increased. A slide valve is opened to allow the oil to descend from the reservoir to the wick. The intensity of the flame is modified by raising or lowering a bell-mouthed glass chimney by means of rackwork mechanism. In a series of experiments on the illuminating powers of different kinds of lamps and candles, Dr. Ure found that the hot-oil lamp, with a given quantity of oil, gave a brighter light than any other form of lamp; or, the light being equal in intensity, the hot-oil lamp was the most economical.

Argand's principle of the mode of admitting air to act on the wick has been the one most generally followed since his time; and many of the subsequent inventions have had relation merely to some modification of this arrangement. The *Solar* lamp, one of the modern kinds, has a provision for sending up air through the interior of the wick, as in the Argand; but the action of the air on the exterior of the wick is made more decided. The wick passes through a hole in the centre of a cap or cone; and the air is admitted so as to act on the flame close to this hole, and in a horizontal direction, while the flame is yet small; so that the exposure of the gaseous products to the air is much more intimate than in the ordinary lamps, and the combustion more complete. Nibb's *oxydite condensing* lamp has a flat wick, with a condensing cap fixed to the upper part of the glass-holder, circular at the base, but tapering upwards to an oblong slot or opening, to allow the flame to emerge from the flat wick. Archer's *pressure* lamp has the oil placed in a flexible bag, with a wick holder, a moveable disk, and a coiled spring. Clark's *pressure* lamp has a strainer or percolator on the lower part of the supply pipe, to prevent impurities from passing into the lamp. Bright's *double-wick* lamp has hollow cylindrical wicks made in a stiffened state ready for use; the wicks are of two different heights, so that one or both parts may be used, according as a weak or a strong light is needed. Among numerous modern arrangements of oil-lamps, some are especially intended for the use of colza or rape-seed oil.

Spirit-Lamps.—In chemical experiments the spirit-lamp has long been a valuable piece of apparatus; but the use of spirit instead of oil, as a food for lamps intended for domestic purposes, is a modern innovation, and has led to much mechanical ingenuity in the construction of the apparatus.

The term spirit is rather a vague one, since there are many kinds of spirit which are inflammable enough to be used for this purpose; but the kind here alluded to is more generally the *spirit of turpentine*, or the liquid distilled from common turpentine by being separated from the resin which is a component ingredient in the last-named substance. When brought to its purest state, this spirit is called by the French chemists *camphine;* and hence the name for some of the modern spirit-lamps. Turpentine being a very abundant produce of the American forests, camphine has long been in use in the United States for lighting shops and public buildings; and it seems to have been from that country that the practice was borrowed and introduced into England. When the import duty on turpentine was lowered some years ago, the price became reduced sufficiently to direct the attention of lamp makers to the practicability of using camphine as a substitute for oil. Many different forms of lamp have resulted from these inquiries; and different processes have also been adopted for freeing the turpentine from a small quantity of oxygen which it contains. Young's *Vesta* lamp is one of those varieties. The principles of its construction are—that, on account of the inflammability of this liquid, provision shall be made for keeping cool the reservoir where it is deposited; that no tube or metal conductor of any description is allowed to pass into or through the liquid from the burning part of the lamp; that a non-conductor of heat is placed between the burner and the liquid; that the cotton wick hangs down from the burner into the spirit, so as to supply spirit to the flame by capillary attraction, without the intervention of any metallic or conducting substance; and that the admission of air to the interior of the wick is managed without the necessity of passing an air-tube through the liquid. All these features and a few others are rendered necessary in the camphine or spirit lamps, on account of the extreme inflammability of the liquid; an inflammability such that the arrangements for an oil-lamp would not be available for a camphine-lamp without much danger. Whether the camphine-lamps receive the name of *Vesta*, or *Gem*, or *Victoria*, or *Paragon*, or *Imperial*, or any other of the many which have been applied to them, they all present in common a reservoir, generally of glass, placed between the supporting pillar and the burner; the spirit is contained in this reservoir, and a cotton wick dips down into it. The chief points in which the several varieties of the lamp differ are in the arrangements for admitting air to the flame.

The increased demand for camphine has raised the price; and it becomes a variable commercial question whether camphine or oil be the most profitable. In a scientific sense, spirit has a great advantage over oil. All lamp-oils contain some oxygen, which neutralises a part of the hydrogen and carbon, and also some oxide or other substance which damps the brilliancy of the flame; whereas rectified camphine, being composed almost wholly of hydrogen and carbon, contains nothing but what is susceptible of combustion. Whether the lamp be so constructed as to admit of this perfect combustion, and also so as to avoid danger, are questions for the consideration of the manufacturer; but in a chemical point of view, camphine seems better fitted for combustion than oil.

It is not alone from turpentine that the spirit may be procured; for tar and naphtha also, if subjected to careful distillation and rectification, will yield a spirit or camphine differing but little from that yielded by turpentine. Mansfield's *Benzole* lamp is founded on an ingenious mode of combining air with spirit vapour. Benzole is a compound of hydrogen and carbon, procured from coal-tar. The mode of employment adopted by Mr. Mansfield consists of sending a stream of atmospheric air, or of common gas, through a reservoir charged with benzole; the benzole vaporises rapidly, and in so doing combines with the air or gas. The reason for this arrangement is, that benzole and similar hydro-carbons contain too much carbon if burned in the ordinary way in lamps; and that an extra dose of hydrogen is required to ensure perfect combustion. Holliday's *Naphtha* lamp is another apparatus for using a cheap hydro-carbon very rich in the last-named element; the naphthalic vapour, as it issues from the jet, is made to mix rapidly with atmospheric air before combustion. Many analogous arrangements have been planned by Donovan, Lowe, Beale, and others, and have been made more or less applicable to alcohol, oil of turpentine, and wood spirit, as well as to benzole and naphtha. Mechanically considered, Holliday's arrangement is ingenious. The admission of air to mix with the hot vapour is regulated by making the burner revolve on the top of the wick tube; there are perforations in both; when the holes are coincident, the current is at its maximum; but it gradually diminishes as the burner is turned round. We may mention also *paraffine* and *petroleum* among the liquids now used as food for lamps; paraffine being deemed in many respects superior to camphine.

Of the late M. Soyer's *spirit* lamp, intended to give heat rather than light, a brief notice will be found under COOKING APPARATUS.

A few words may be added concerning two important matters connected with lamps; namely, the comparative illuminating powers of different kinds, and the means of carrying off the products of combustion.

Pectet, Dr. Ure, and Dr. Fyfe have all instituted experiments bearing on the former of these two questions. Pectet experimented on candles only. He determined what would be the value of different kinds of candle, sufficient to produce a given intensity of light, as determined by Carcel's lamp as a standard. They rank in the following order, the first being the cheapest:—tallow candles, six to the pound; ditto, of eight to the pound; pressed tallow; stearine; spermaceti; wax. This relation was as to *price* only. The relative *weights* of material consumed followed a different order of arrangement, the spermaceti being the least, and the pressed tallow the greatest. In Dr. Ure's list the relative quantities of light for a given price, or the relative cheapness of a given quantity of light, among several kinds of lamps and candles, are placed in the following order:—Hot-oil lamp, with southern whale-oil; Carcel lamp, with sperm-oil; hot-oil lamp, with sperm oil; hot-oil lamp, with common olive-oil; hot-oil lamp, with cocoanut-oil; French lamp, with sperm-oil; mould tallow candles; Palmer's spread-wick candles; stearic acid candles; cocoanut stearine; spermaceti candles; wax candles: the first being, in point of economy, the cheapest, and the last the dearest. Dr. Fyfe's experiments were of a more extensive character, embracing a larger number of sources of illumination. Assuming a given intensity of gas-light as a standard, he experimented on ten varieties of candles, and found their relative cheapness, in producing the given degree of light, to rank as follows:—tallow with single wick, cocoa, composite, palm, tallow with double wicks, wax, diaphane, margarine, spermaceti, and composition. In another table, comparing gas, oil, and candles together, he assumed an Argand gas-flame as a standard of intensity and price, and gives the following arrangement in respect to the ratios of relative cheapness, the intensity of light being uniform:—

Argand gas-flame	1·00
Solar lamp	2·00
Naphtha	2·00
Solar oil in Argand lamp	3·98
Whale-oil	5·00
Sperm-oil	8·00
Tallow-candle (two wicks)	12·70
Cocoa candle	13·10
Tallow candle (one wick)	13·50
Composite	14·50
Palm	18·90
Wax	25·90
Diaphane	27·10
Margarine	28·40
Spermaceti	29.20
Composition	29·20

According to this table, composition candles are nearly thirty times as costly as gas for an equal intensity of light.

Dr. Faraday has introduced an important arrangement for carrying off the products of combustion in gas and oil lamps. This arose out of a complaint, on the part of the members of the Athenæum Club, that the air of their library was vitiated and the binding of the books injured by the lamps then used. Dr. Faraday investigated the subject, and shortly afterwards communicated to the Institute of Civil Engineers the mode which he proposed to adopt for remedying the evil. In a paper communicated to this body he adduced striking proof of the magnitude of the product resulting from combustion. "A pint of oil, when burned, produces a pint and a quarter of water, and a pound of gas more than two and a half pounds of water; the increase of weight being due to the absorption of oxygen from the atmosphere, one part of hydrogen taking eight parts (by weight) of oxygen to form water. A London Argand gas-lamp, in a closed shop-window, will produce in four hours two pints and a half of water; a pound of oil also produces nearly three pounds of carbonic acid, and a pound of gas two and a half pounds of carbonic acid. For every cubic foot of gas burned, rather more than a cubic foot of carbonic acid is produced." As the water produced deadens the effect of the flame, and as the carbonic acid is very deleterious to the lungs, Dr. Faraday contrived a mode of carrying both off without allowing them to mix with the air of the room. Air is admitted to feed the flame, nearly in the usual way; but when the products of combustion have arrived at the top of the glass chimney, their progress is arrested by a covering of talc, and they are compelled to pass down between the chimney and another larger glass chimney concentric with it. The open space between the two chimneys communicates with a pipe which is conducted in any convenient way into the open air; the carbonic acid, aqueous vapour, smoke, and other emanations from the flame have no means of escape except through this tube, and they are thus wholly cut off from contact with the air of the room. The mode of carrying out the arrangement may be varied in its details; but the general result is said to be that the light is brighter, the space around the lamp cooler, and the air of the room less vitiated than when common open burners are used.

Many other ingenious arrangements have since been adopted by different inventors; either to lessen the production of smoke, or to carry off the products of combustion without allowing them to mix with the air of the room.

LIGHTS AT SEA. So much attention has been already given to this subject under the heading COLLISIONS AT SEA in this work, that little remains to be noticed here. The suggestions therein made have been well received by officers of the navy and merchant services, and the question is by no means dormant with the authorities; a perfect system of lighting our coasts seems to be not distant.

LIGHTS, FLOATING. [TRINITY HOUSE.]

LIGHTS, NORTHERN. [POLAR LIGHTS.]

LIGNIN. From the Latin *lignum*, wood. The structure of wood is determined by the superposition of a number of little cells or vessels, more varied in shape but somewhat resembling those of the honeycomb. The material composing this structure is cellulose [CELLS; TISSUES, VEGETABLE, in NAT. HIST. DIV.], but the chief substance which fills up the cell, which incrusts and even penetrates the walls, and which gives firmness and hardness to the whole, is *lignin*. The harder and tougher a piece of wood, the more lignin does it contain.

The purification of lignin, so as to obtain it in a state sufficiently free from other matter to admit of a determination of its composition being made, is exceedingly difficult. Like cellulose it is insoluble in water, alcohol, ether, or dilute acids, and may therefore be freed from many other matters by successively treating it with these agents. Its chief characteristic is, however, a greater solubility in alkaline liquids than is possessed by cellulose.

Lignin contains a greater per centage of hydrogen than is necessary to form water with its oxygen, whereas cellulose contains these two elements in exactly the required proportions, cellulose being represented by the formula $C_{24}H_{20}O_{20}$, whilst lignin has been described as $C_{26}H_{24}O_{20}$. Submitted to destructive distillation lignin yields acetic acid, hence the source of that acid, when wood is strongly heated in iron cylinders, as described in treating of *pyroligneous acid* [ACETIC ACID]. That it is the lignin which chiefly furnishes the acid is proved by the fact that the hardest varieties of wood—those containing most incrusting matter, or lignin—yield the largest amount of acid, when equal weights of the wood are operated upon.

Lignin is slowly acted upon by chlorine, and is dissolved by an aqueous solution of that gas. Sulphuric acid abstracts water from it, and sets free carbon. Iodine does not colour it. It is tasteless and odourless, and is insoluble in water and alcohol.

Lignin is identical with the substance noticed by Payen as *Matière incrustante*.

In its isolated condition lignin has no practical value, but the application of it as *ligneous fibre* in the manufacture of linen, cotton, hemp, &c., &c., is obviously of the highest importance.

See also LIGNIN, in NAT. HIST. DIV.

LIGNONE, a volatile liquid obtained from crude wood spirit. It is probably a mixture of several substances, as analyses of this body made by different chemists exhibit great discrepancies.

LIGUSTRIN, a bitter solid substance, of unknown composition, found in the *Ligustrum vulgare*.

LILACIN (*Syringin*), a crystalline substance found in the buds and bark of the common lilac. It possesses a nauseous bitter-sweet taste, is soluble in 8 to 10 parts of water, or the same amount of alcohol, but insoluble in ether. Dissolved in concentrated sulphuric acid, the solution first assumes a greenish-yellow tint, passing gradually to a violet-blue, which becomes amethyst-red when diluted with water. Lilacin does not contain nitrogen, but its exact composition is unknown.

LIMB. (Astronomy.) The edge of a planet is called its limb; also the edge of any circle which forms part of an astronomical instrument.

LIME. In building operations *lime*, the dehydrised oxide of calcium, in its various modifications is used for the purpose of forming the material by means of which the small materials used in masonry or brickwork, are bound or cemented together; and the precise word lime is used in contradistinction to *plaster* (or the sulphates of lime), or of *cement* (or the highly silicated carbonates of lime and alumina), to designate the materials obtained from the calcination of carbonates of lime of comparatively pure and simple composition. The various descriptions of limes, technically considered, are those which are known by the names of the rich, the poor, the moderately hydraulic, the hydraulic, and the eminently hydraulic limes; and the application of these names depends exclusively upon the manner in which the respective limes pass through the stages of slaking, or of setting. Very little attention is paid in practical building operations to the mechanical structure of the stones from which the various limes are obtained, and the qualities of the caustic limes themselves constitute the only recognised elements of the classification.

The materials obtained from the calcination of limestones containing less than 6 per cent. of the silicate of lime, and otherwise composed of the pure carbonate, are those called the *rich limes*, on account of the remarkable increase of volume they assume when water is added to them (or when they are *slaked*), for the purpose of being reduced to the state of the plastic material, to be subsequently mixed with sand, for the formation of mortar. They increase, in fact, as much as 3½ or 4¼ of their original volume when measured in the lump, and about ¾ of their original weight; they absorb in so doing about 1¼ times their bulk of water. Naturally contractors prefer limes of this description; for, to use one of their own phrases, "they carry more sand;" but such pure rich limes never *set* (or harden by crystallisation), when in large bodies, or large masses of work, and they are very soluble in frequently renewed water. It follows, therefore, that pure rich limes should never be used for external walling, or for works likely to be exposed to the action of running or of tidal water. In sea water another source of danger arises from the tendency of the lime to pass into the state of the sulphate of that base. Some curious illustrations of the length of time during which large bodies of slaked rich lime will remain in a plastic state are to be found recorded in Vicat's 'Recherches sur les Chaux."

When the limestones operated upon contain from 1 to 30 per cent. of impurities, such as the oxides of iron, manganese, magnesia, and sand in the form of insoluble silica, they yield limes which do not increase in bulk when slaked (in any notable manner); and are therefore known as the *poor limes*. The hydraulic limes, to be noticed hereafter, are also poor, in so far as their expansion is concerned; but they differ from the class usually known by that name in this respect, namely, that the poor limes, containing impurities such as are above-named, do not set under water within any reasonable time, if at all; whereas, the hydraulic limes possess that faculty in variable degrees.

The *hydraulic limes* are those which are obtained from the calcination of limestones containing proportions of the silicate of alumina, in combination with the pure oxide of calcium, varying within the limits of from 6 to 30 per cent. of the silicate of alumina in the whole mass; and it appears that it is upon the greater or less rapidity of formation, and of the stability of the hydrated silicate of lime and alumina thus formed by the addition of water to the caustic lime, that this class of materials owes the power of setting under water, and of resisting the solvent action of the latter, from which circumstance its name is derived. When the proportion of the silicate of alumina ranges between the limits of from 6 to 8 or 12 per cent., the lime becomes simply *moderately hydraulic;* when the proportion ranges between 12 and 20 per cent., the lime is *hydraulic;* and when it ranges between 20 and 30 per cent., the lime becomes *eminently hydraulic;* and at last closely approaches the character of the cements. According also to the proportion of the silicate of alumina present in the limestone is the lime obtained from it more or less rich, for the moderately hydraulic limes swell nearly as much as the rich limes in slaking, and with nearly equal rapidity and evolution of heat; whereas the hydraulic limes only increase from 1¾ to 2½ of their original volume, they slake slowly, and give out comparatively little heat. In contradistinction to the rich limes, however, they set rapidly in the open air, and permanently under water; for which reasons they alone should be used for exposed or submerged walls. Artificial hydraulic limes are made by the addition of clay, containing soluble silicate of alumina, to the pure carbonate of lime, and by calcining those materials together; or it is made by the addition of pounded and rather under-burnt brick or tile-dust to the mortar of rich limes. The artificial hydraulic limes obtained by the simultaneous calcination of the lime and clay are, it may be observed, much more fitted to resist the solvent action of running waters, than those in which no pyrogenous combination takes place between those elements.

The common chalk lime of the neighbourhood of London may be considered to represent the type of the *rich limes;* some of the impure oolitic stones yield the decidedly *poor limes;* and the blue lias lime may be taken to represent the type of the *hydraulic limes;* the so-called *gray stone lime* of London is simply a moderately hydraulic lime; whilst strictly speaking, the *Portland cement* ought to be considered an *eminently hydraulic artificial lime* [PORTLAND CEMENT]. The gray stone lime is obtained from the basement beds of the chalk; and the *blue lias lime* from the formation of that name. The Romans seem to have used pounded brick dust for the purpose of making artificial hydraulic limes, whenever they could not obtain puzzuolanos, or similar volcanic silicates of alumina; and the modern engineers have largely employed the latter class of materials, such as the Italian puzzuolanos, or the trass of Westphalia, in their marine works. Of late years, however, the use of the Roman and of the Portland cements has almost entirely superseded that of the mechanical mixtures of lime and the silicate of alumina.

The proportions of sand it may be desirable to mix with a lime for the purpose of making mortars, must vary with the richness of the limes; and it may briefly be said, that it ought to be equal to the amount of expansion of the lime itself in slaking; that is to say, that a lime expanding to 3 or 4 times its original volume may be mixed with three or four times its said volume of sand, and so on. In practice, these proportions of sand may often be exceeded without inconvenience; and it would appear that the chemical nature of the sand has a marked influence upon the character of the resulting mortar; for in proportion as the sand participates of the character of the soluble silicate of alumina, or in proportion, in fact, as it contributes to the formation of a double silicate of lime and alumina, will the compound between it and the lime acquire the property of hardening under water.

It may be added, that when the rich, or the poor limes, are immersed in water, in vessels open at the top, as is done in trials upon the quality of this class of materials, they never set. The hydraulic limes set after 6 or 8 days' immersion, and at the end of about 6 months they become as hard as the softer kinds of chalk; and the eminently hydraulic limes set within 3 or 4 days after their immersion, becoming within 6 months as hard as ordinary limestones. The pure lime itself is soluble, to the very last grain, in water, in proportions varying with the temperature of the latter. Dr. Dalton considered that at moderate temperatures (about 60°), water could take up $\frac{1}{778}$ of its own weight of lime; and at 212° Fahr., it is able to take up about $\frac{1}{1270}$ of that weight. The colouring material used in building operations under the name of lime-white, is merely water containing an excess of lime, to which a little size should be added, in order to counteract the tendency of the lime to detach itself from the surfaces to which it has been applied when the water has evaporated. The rich lime is used in some trade operations, as in tanning; and also to a great extent as a disinfectant in the form of lime-white upon walls, and as a soluble hydrate in the case of waters containing impurities in suspension. In farming operations it is also largely employed, as a dressing or even as a manure; and latterly, the lime-light may be considered to indicate a further remarkable application of this important material. This light is obtained by igniting the united jets of oxygen and hydrogen gas upon a piece of caustic lime, which thus becomes heated to a most intensely luminous degree. The practical applications of lime in building operations will be further referred to under MORTAR; PLASTERING; SLAKING.

LIME, *Medical Properties of.*—Though lime exists in almost all plants, yet it is more particularly the characteristic element of animal structures, into which it is introduced with the food, as well as often by the water drank, especially when hard. It is present in small quantity in sea-water (Delabeche). A deficiency of lime in the body causes a softness of the bones to result; while an excess of it occasions preternatural induration of the bones, morbid growths from them, or exostoses, ossifications of the cartilages, of the heart and arteries, as well as depositions of calcareous concretions in various glands and cavities, such as the urinary bladder. [CALCULUS.] The action of lime on the human system varies considerably according to the state in which it is when introduced into or applied to it. Thus quick-lime is violently escharotic, causing inflammation and often decomposition of the part which it touches, and is never employed save when the actual destruction of the part is intended. In a state of great dilution, such as that of lime-water, or when rendered mild by combination with carbonic acid or phosphoric acid, it scarcely produces any immediate or direct action beyond what results from its combining with the acids of the stomach, and, if in considerable quantity, absorbing the mucous and other secretions. It likewise checks the secretions of remote mucous membranes with which it is not brought into contact, such as those of the bronchia. After its absorption into the system, it augments the secretion of the kidneys, and at the same time hinders the excessive formation of uric acid.

Lime-water has an effect beyond what results from its combining with any excess of acid, of a kind to create diarrhœa, for it acts as an astringent and tonic. Hence it removes a tendency to the disease, as well as cures it, when debility is the cause. Its action is often promoted by combination with aromatics, as in the aromatic confection, and occasionally with opium. Carbonate of lime in the form of prepared chalk acts in a similar way, but is accompanied with a disengagement of carbonic acid, which is sometimes beneficial, at other times distressing to the patient. [ANTACIDS; ASTRINGENTS.] Lime-water is often the most effectual means of reconciling the stomach to a milk-diet, and is also of great service in removing the tendency to the generation of worms. [ANTHELMINTICS.] Lime-water with olive oil is a useful application to burns, called carron oil, or *Linimentum calcis* of the Pharmacopœia.

Chloride of lime appears to exercise a specific power over the lymphatic vessels and glands, increasing their activity, so that under its influence various swellings and indurations have first softened and then disappeared. This is the more remarkable as bronchocele, or enlargement of the thyroid gland, seems to be caused chiefly by drinking water abounding in calcareous salts. Chloride of lime has been strongly recommended in scrofula. It is generally given in the form of solution, but in a dry state, with extract of conium, it is even more useful.

The great tendency of chloride of lime to absorb humidity from the air renders it of much utility in preserving steel and surgical instruments from rust. Hence the presence of a portion of it in chests sent to sea protects the fine edge from erosion. For the use of the chloride (hypochlorite) of lime as a disinfecting agent, see ANTISEPTICS, CHLORINE, and DISINFECTANTS.

Phosphate of lime has been recommended in rickets and other diseases of the bones in which this earth is deficient. Its utility is increased by using at the same time phosphate of iron, or, if that cannot be obtained, the sesquioxide or rust of iron. This salt and many other salts of lime exist in different mineral waters, and some of their effects are due to this impregnation. [MINERAL WATERS.]

Lime-water, if at hand, affords an efficient antidote to poisoning with some of the mineral acids, such as sulphuric or hydrochloric, also oxalic acid. Some of the lime or plaster torn from the walls of the room, diffused through water, will answer this end.

LIME. [CALCIUM; *Oxygen and Calcium.*]

LIME. [MANURE.]

LIME KILNS. The description of ovens in which limestones are subjected to the process of calcination are known by the name of *lime kilns.* These structures are usually built of brickwork lined with fire-bricks, and in shape are either rectangular straight prisms, portions of cylinders, cylinders surmounted by truncated cones, reversed straight-sided cones, or cones produced by the revolution of an ellipsoid. The first three forms are used for what are called *intermittent kilns*, whether of wood or coal; the next two forms are used for what are called *running kilns*, and are those in which coal is burnt; whilst the last of all is most generally used when peat is the fuel employed. In the intermittent kilns the main body of the fuel is applied below the charge, and after it has been consumed the fire is let out and the kiln cooled; in the running kilns the fuel is intermixed with the charge, and the calcined lime, falling to the bottom, is gradually withdrawn as it is burnt, so that the operation is, technically speaking, continuous. Local considerations of the cost of construction, of fuel, and of the nature of the demand, must regulate the choice of the particular description of kiln.

It is calculated that the degree of heat required in a lime kiln is about from 15 to 30 of Wedgewood's pyrometer, and that in intermittent kilns this heat must be maintained for between 3 or 4 days. It is supposed that about 60 cubic feet of oak, 117 feet of fir, about the same quantity of peat, and 9 cubic feet of coal are required to calcine 35 cubic feet of limestone, in intermittent kilns; and that 7 cubic feet of coal are able to calcine that quantity of lime-stone in running kilns. The lime-stones lose, on the average, 45 per cent. of their weight by the evaporation of the water, and the expulsion of the carbonic acid gas; but they hardly diminish in volume more than from 1 to 2 per cent. A great deal of the loss of weight by calcination is permanent; for even after the lime has been hydrated thoroughly, it remains about from 15 to 17 per cent. less in weight than it had previously been, when in the form of the stone.

LIME LIGHT. [DRUMMOND'S LIGHT.]

LIME-TREE: *Economical Uses.* The wood of the European Lime, which is of a yellowish-white colour, is close-grained, soft, light, smooth, and not liable to be attacked by insects. It is used for the sounding-boards of pianofortes; for many articles of cabinet-work and domestic utensils; for small boxes to contain perfumery and drugs; and for some of the better kinds of children's toys. Curriers, glovers, and shoemakers find lime to be the best wood for their cutting-boards. The colour, grain, softness, and surface texture have given lime-wood a high favour among carvers; many of the fine carvings at Windsor Castle, Chatsworth, and Trinity College Library at Cambridge, are in this wood. Hollar, the wood-engraver, is said to have used lime-tree for his blocks.

The charcoal obtained from the lime ranks next to that from hazel for gunpowder. Baskets and cradles are sometimes made from the twigs. The bark is twisted into rope, twine, and matting, in some countries. The Russian peasants often make the soles of shoes with the outer bark, while the bark of the young shoots is woven into a material for the uppers. They also manage to make baskets and boxes with strips of the inner bark; and employ the outer bark of the older trees as a substitute for tiles and slates for their huts. In various countries the fibres of the inner bark are so prepared as to be used as a substitute for hemp and flax in making fishing-nets, cloth, &c. The matting, so much used by upholsterers and gardeners, comprises, among other kinds, that which is made in Sweden and Russia from lime-bark; the pieces are steeped in water till the layers separate freely; and these layers, when separated into ribands or strips, and dried, are woven or interlaced into matting. The leaves of the lime-tree are used as cattle-food in some parts of Europe. The sap will yield sugar, but not to a profitable extent. A sort of cocoa has been prepared from the fruit. The honey procured by bees from the flowers of the lime-tree is said to excel all others in delicacy. It is an important article of commerce in Lithuania, Galicia, Transylvania, the Ukraine, Moldavia, and the neighbouring parts of Europe; and the choice liqueur *rosoglio* is mainly prepared from it.

LIMIT: LIMITS, THEORY OF. The word limit implies a fixed magnitude to which another and a variable magnitude may be made as nearly equal as we please, it being impossible however that the variable magnitude can absolutely attain, or be equal to, the fixed magnitude. In this strict sense of the word there are two conditions which must be fulfilled before A can be called the limit of P: first, P must never become equal to A; secondly, P must be capable of being made as nearly equal to A as we please.

The method of limits is in reality nothing more than one way of evading the use of the word infinite in an absolute sense [INFINITE]: which may be shown as follows. If we take two common algebraical expressions, such as x and $x x$, or x^2, there can be no objection to saying that when $x=7$, $x^2=49$, because 7 is a definite number, and the operation 7×7 is perfectly intelligible. And we may, if we please, say that when x approaches 7, x^2 approaches 49, so that if x may be made as near as we please to 7, x^2 can be made as near as you please to 49. Or, 7 being the limit of x, 49 is the limit of x^2. The preceding is superfluous, because it is more simple to say at once that x^2 *is* 49 when x *is* 7. But suppose that x, instead of being taken at pleasure, must be determined by means of y; and let the investigation of the relation between x and y lead to

$$x = 7 + \frac{1}{y}:$$

then, so long as y has any finite value, x must be more than 7; nor can the assertion $x=7$ be made without the implication that y is infinite. In this case then we can only say that x can be made as near as you please to 7, if we may take y as great as we please; in which case x^2 can be made as near as you please to 49. In the language of the article infinite, we say (for abbreviation, as explained in INFINITE) that x is 7 and x^2 is 49, when y is infinite: in the language of the present article, we say that *x has the limit* 7, and x^2 the limit 49, when *y increases without limit.* We shall now translate the various illustrations given in the article just cited, from the language of infinites into that of limits.

When z is infinite, A is equal to B. If A be a fixed magnitude, read —If z increase without limit, A is the limit of B: if B be a fixed magnitude, read—If z increase without limit, B is the limit of A: if both A and B be variables, read—When z increases without limit, A and B approach to the same limit.

A finite quantity x, divided by an infinite quantity, is nothing. For this read—When the denominator of a fraction increases without limit, the numerator remaining the same, the fraction diminishes without limit.

Every circle is a regular polygon of an infinite number of sides. For this read—If the number of sides of a regular polygon inscribed in a circle be increased without limit, the polygon approaches without limit to the circle: or, the circle is the limit of all the regular polygons which can be inscribed in it.

When x is infinite, A and B are both infinite, but A is infinitely greater than B. For this read—When x increases without limit, A and B both increase without limit, but the ratio of A to B also increases without limit, or the ratio of B to A diminishes without limit.

When $x=a$, z is infinite. For this read—When x approaches without limit to a, z increases without limit.

Two infinitely great quantities may have a finite ratio. For this read—When two quantities increase without limit, their ratio does not necessarily increase without limit, but may have a finite limit.

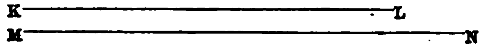
Two infinitely small quantities may have a finite ratio: or—when two quantities diminish without limit, their ratio does not necessarily diminish without limit, but may have a finite limit.

When A is infinitely small, B is infinitely great. For this read—When A diminishes without limit, B increases without limit.

An infinitely small arc of a curve is equal to its chord. For this read—When the arc of a curve diminishes without limit, the ratio of the arc to the chord, or the fraction $\frac{\text{arc}}{\text{chord}}$, approaches the limit unity.

Of two infinitely small quantities, one may be infinitely smaller than the other. For this read—When two quantities diminish without limit, it is also possible that their ratio may diminish without limit.

Hitherto we have been dealing with considerations which may appear purely verbal, but which are nevertheless connected with the translation of two very different modes of conception each into the other. But were they declared to be merely verbal, they would not be unimportant. It is of great consequence that the fundamental notions of mathematics should be expressed in those terms which have always represented the rude and unrigorous form in which they are expressed in common life: and also, when the form just alluded to has given birth to several different modes of expression, it is necessary to point out the connection of these with each other, and to assimilate their defined meanings. But, so far as demonstration is concerned, we have made no step by using one form of words instead of another, or even by substituting the notion of a limit unattainable for that of the same magnitude attained by the supposition of absolute infinity. The theorem by which rigorous results are obtained is the following: If two variable magnitudes, A and B, be always equal, and if they have limits, namely, P the limit of A, and Q of B; then P and Q must be equal. This proposition may seem almost self-evident; it is not however a perfect axiom, and the method of exhaustions [GEOMETRY] was employed by Archimedes to prove it, or rather, to prove the proposition that if two variable magnitudes be always in a given ratio, their limits are in that ratio. The latter form of the proposition is requisite in Geometry [PROPORTION]; the former is sufficient in Algebra; and the proof is as follows: Supposing A and B for instance to be varying lines, always equal, let their limits, if possible, be the unequal lines K L and M N.



Since A and B are equal, and since the first can be made as near as we please to K L, and the second to M N, it follows that the latter pair are as nearly equal as we please. But this is not true, since the limits are fixed and invariable magnitudes, differing (if they differ at all) by a fixed and invariable quantity. Consequently the limits cannot be other than equal. The proof of the proposition of Archimedes is given in GEOMETRY.

This proposition, being once understood, is more fruitful in applications than almost any other. We shall give one instance from geometry and one from algebra.

Circles are to one another as the squares on their diameters. For this proposition is evidently true of the regular polygons inscribed in the two circles with the same number of sides; and the polygons may be made as nearly equal as we please to the circles. The limits of the polygons then (or the circles themselves) are in that ratio which the polygons always preserve.

As an instance from algebra, apply the BINOMIAL THEOREM to the development of

$$(1+nx)^{\frac{1}{n}} = \text{A},$$

which gives, by an easy transformation,

$$1+x+\frac{1-n}{2}x^2+\frac{1-n}{2}\,\frac{1-2n}{3}x^3+\ldots\ldots(\text{A}),$$

a series which (by the method in CONVERGENT) is always convergent when nx is less than unity. Apply the same method to the development of

$$(1+nx)^{\frac{y}{n}} = \text{B};$$

which gives in the same manner

$$1+yx+y\frac{y-n}{2}x^2+y\frac{y-n}{2}\,\frac{y-2n}{3}x^3+\ldots\ldots(\text{B}).$$

Now B is evidently A^y; and if when n diminishes without limit, B and A approach the limits P and Q, then B and A^y (equal quantities) will approach the limits Q and P^y, which are therefore equal. But the limit of A, when n diminishes without limit, is

$$1+x+\frac{x^2}{2}+\frac{x^3}{2.3}+\ldots\ldots=\text{P}.$$

That of B, on the same supposition, is

$$1+xy+\frac{x^2y^2}{2}+\frac{x^3y^3}{2.3}+\ldots\ldots=\text{Q}.$$

Hence the second of these series is the yth power of the first; a theorem which the algebraical student will recognise as one of the most important in that science.

The *method of limits* generally means the Differential Calculus exhibited upon the principles explained in the article DIFFERENTIAL COEFFICIENT. It is admitted, by a large majority of those who are capable of forming a judgment, that the method by which this theory should be established is either the method of limits, or that of Lagrange [FUNCTIONS, THEORY OF], or a mixture of the two. The number of those who contend for the second has very much diminished of late years; and the controversy (if such a thing can be said to exist) lies between the first and third. The reader will find in the eighth number of the Treatise on the subject, published by the Society for the Diffusion of Useful Knowledge, some additional reasons for considering the use of assumed expansions as fallacious. See also SERIES.

It has been customary in elementary mathematical works to endeavour to postpone the theory of limits as late as possible. Such an attempt can never be very successful; a clear understanding of the notion of a limit may easily be, and often is, deferred *sine die*, but the necessity for such an understanding enters with the sixth book of Euclid. We shall even undertake to show [PROPORTION] that the fifth book cannot be properly understood without it.

Wherever we have occasion to speak of a supposition as true, *however small a quantity may be*, we are really involving the notion of a limit. We cannot, for example, even define uniform velocity without it. If s be the number of feet described by a point in the number of seconds t, there is uniform velocity when $s \div t$ is the name for all values of t, *however small*, begin to reckon t at what part of the motion we may. This is saying that, begin where we may, the limit of $s \div t$ is always the same.

One of the best studies in the theory of limits is the first section of Newton's Principia. In the article Prime and Ultimate Ratios we shall present one or two of the leading propositions.

LIMITATIONS, STATUTE OF. [Statute of Limitations.]

LIMMA (λεῖμμα, *a remainder*), in ancient Greek music, is that which remains of the greater tone when the apotome is taken from it. [Apotome.] The greater tone, as, for instance, C, D, is divisible into nine commas; of these, five constitute the apotome, four the *limma*: or, $\frac{5}{9} + \frac{4}{9} = \frac{9}{9}$. The ratio of the *limma* is $\frac{243}{256}$, and for all practical purposes it may be considered as the minor semitone of the modern scale.

LIMONIN ($C_{22}H_{26}O_{13}$?) is a bitter crystalline substance found in the seeds of lemons and oranges. It dissolves in sulphuric acid with a red colour, but the addition of water reprecipitates it.

LINE. The definition of a line, as given by Euclid, will be discussed, with other matters relating to it, in the article Solid, Surface, Line, Point (Definitions of).

LINE. The French used to divide their inch into twelve lines, and the line into twelve points, which measures are out of date, since in all scientific investigations the metrical system is adopted. Sometimes, but rarely, the line has been divided into ten points, thus giving 1440 points to the foot: the French metrological writers, particularly the older ones, frequently give the measures of other countries in 1440ths of their own foot. Some English writers have divided the inch into lines. The French line is ·0888 of an English inch, and is also two millimetres and a quarter.

LINEAL DESCENT. [Descent.]

LINEAR (Algebra). As all equations connected with straight lines are of the first degree, the continental writers frequently call equations of the first degree linear equations.

LINEAR DIMENSIONS. [Solid, Superficial, and Linear Dimensions.]

LINEN MANUFACTURE. Linen (French, *Tissue de Lin*; Spanish, *Tela de Lino*; German, *Linnen*; Dutch, *Lynwaat*; Italian, *Tela*; Russian, *Polotno*) is a general name for cloth woven with the fibres of the flax plant (*Linum usitatissimum*), a manufacture of so ancient a date that its origin is unknown. Linen cloths were made at a very early period in Egypt; as we see from the cloth wrappings of the mummies, which are all of this substance. It appears also that linen was, in the time of Herodotus, an article of export from Egypt. (ii. 105.) In the present day, linen as a generic term includes woven fabrics of hemp as well as flax, except the special kinds known as canvas, sail-cloth, and a few others.

England has manufactured linen from an early but unknown date. The growth of the manufacture in Ireland is ascribed to the legislative obstruction raised in the reign of William III. to the prosecution in that part of the kingdom of the woollen manufacture, which it was alleged interfered prejudicially with the clothiers of England; the linen weavers being at the same time encouraged by premiums of various kinds distributed by public boards authorised by parliament, and by bounties paid on the exportation of linen to foreign countries. It is known that linen was woven in Ireland as early as the 11th century; that Louis Crommelin, driven from France by the revocation of the edict of Nantes, established the manufacture on an improved basis; that in 1711 the Duke of Ormonde, lord-lieutenant, ordered that funeral hat-bands and scarfs should be made of linen, as a means of encouraging the trade; that a little machinery began to be applied to the manufacture in 1725; and that Dr. James Ferguson, of Belfast, greatly improved the processes by a method of bleaching adopted soon after the middle of the century. Messrs. Mulholland, of Belfast, began to spin flax by machinery in 1820. In 1828 the Linen Board was dissolved; and in 1841 a society was founded for encouraging the growth of flax in Ireland. We have no certain means for ascertaining the growth of the linen manufacture in that country. The only facts by which we can approximate to its amount are afforded by custom-house records, which do not reach back to an early date, and are wanting for the years subsequent to 1825, when the intercourse between Great Britain and Ireland was put upon the footing of a coasting trade. The average quantity of linen exported annually from Ireland, principally to England, in the three years ending March, 1790, was 34,191,754 yards; in the three years ending March, 1800, the yearly average was 36,112,369 yards; and the average annual exports in the last three years of each of the next two decennary periods was 40,751,889 yards, and 48,265,711 yards, respectively. In 1820, the quantity was 42,665,928 yards; and in 1825, it amounted to 52,560,926 yards. An estimate made by the Irish railway commissioners in 1835, put down the quantity at 70,209,572 yards of linen, the value of which was 3,730,854*l.* Since the last-named date, the means of forming an estimate have been very doubtful.

The linen manufacture was introduced into Scotland early in the last century; and in 1727 a board of trustees was appointed for its superintendence and encouragement. Notwithstanding this and the further stimulus afforded by premiums and bounties, the progress of the manufacture in that part of the kingdom was for a long time comparatively unimportant. At Dundee, the great seat of the Scotch linen trade, the whole quantity of flax imported in 1745 was only 74 tons. In less than half a century after that time the annual importation of flax was 2500 tons, and there were exported 8,000,000 yards of linen beyond the quantity used at home. At this rate the manufacture continued nearly stationary until after the peace in 1815, when a new impulse was given to it. Improved fiscal arrangements afterwards greatly increased the production in Scotland, especially at Dundee.

In the article Flax, an account is given of the chief processes to which the fibre is subjected in preparing it for the spinners. A very few additional details will suffice here, to show how many attempts have recently been made to supply our linen-manufacturers by home growth. All agree that some improved mode of retting is necessary to render flax-culture profitable in these islands. Russian, Prussian, and Belgian flax keep down the price of English and Irish to a point which renders the profit often doubtful. To lessen the expenses, and improve the quality in various ways, several new modes of retting have come under public notice within the last few years. The *dew*-retting and *water*-retting are described in the article above cited. The *mechanical* retting has been conducted in various ways by Lee, Hill, Bundy, Donlan, Davy, and others. It is a quick and economical process, and seems to be applicable when the crop is of too poor a character to pay for the expense of steeping; or in districts where steeping is effected with difficulty; or in cases where coarse yarns only are required. The *steam*-retting and the *hot-water*-retting are intended to effect the separation of the fibre without producing the fermentation which results from ordinary retting, with its offensive odour and its waste of substance. Schenk's hot-water process was patented in 1846, and a rettory was established in Mayo to test its value. Watts, Buchanan, and other inventors, have varied in many ways the application of heat to the process. The *chemical*-retting is founded on the same considerations as those by steam and hot-water: namely, that the dry or mechanical process is not suited to the production of fine yarn, owing to the large portion of the substance of the plant which remains attached to the fibre. The ordinary retting is in effect chemical, seeing that it is fermentation which sets free the fibre from the other parts of the plant; the hot-water and steam processes are also chemical, for they dissolve the non-fibrous portions even though they do not ferment them; but the chemical processes here adverted to are those in which alkalies or other agents are added to the water, to increase the separating effect. The systems of Lilljikreuse, Palinquist, Gay Lussac, Berthollet, Claussen, and many others, are chemical in this sense. At one time, Claussen's method attracted so much attention that 3000 acres were laid down in flax in Ireland, for conducting the process on a large scale. Some observers have thought, on comparing the results of the dry and wet processes, that the best plan would probably be to combine both—to separate the fibre from the boon roughly by a machine; to use the boon as fodder or manure; and to sell the fibre to flax preparers, who would apply a wet process for finishing it. Not only have inventors brought forward all these various projects, but numerous suggestions have in other ways been made to encourage the home growth of flax. The British government has not recently offered any direct bounty or encouragement for the growth of flax; but the New Zealand government, in 1856, offered 4000*l.* in various sums as prizes to persons who would produce New Zealand flax good enough and cheap enough to encourage the colonists to attend to this branch of industry. As to joint stock companies, many have been suggested in reference to flax growing and manufacture. One was proposed in 1859, to work out Cator's plan; the objects of which were to encourage the growth of flax at home, to buy the plants, to establish rettories, to ret the flax to a certain stage, and sell it to the spinners—thereby relieving the grower, as an agriculturist, from all the mechanical and chemical difficulties of retting. Notwithstanding all these efforts, however, the home growth of flax makes slow progress. Ireland had 50,000 acres under flax in 1812; this rose to 110,000 in 1826; a gradual decline brought it down to 58,000 in 1847; it rose again to 170,000 in 1853; since which year it has fluctuated greatly. Taking the whole of the United Kingdom, we did not in 1858 grow one-fourth of the flax required by our spinners. The Irish produce seems to be about 6 cwt. of clean fibre to the acre.

Until recently little machinery was used in the production of linen cloth. After the separation of the ligneous fibre of the plant, the distaff and common spinning-wheel were employed for the preparation of the thread or yarn; and the hand-loom generally, in its simplest form, was used for weaving the cloth. Within the present century the first attempts were made at Leeds to adapt the inventions of Hargreaves and Arkwright to the spinning of flax. Mill-spun yarn is now universally employed by the linen-weavers of this kingdom for the production of the very finest lawn, as well as of the coarsest linen; and of late years the use of the power-loom has been adopted for weaving all but the very finest and most costly fabrics. These improvements have rendered this country independent of all others for the supply of linen yarn of every quality, and diminished in a most important degree the cost of linen fabrics; so that British yarns and cloths are now profitably exported to countries with which the manufacturers of Great Britain and Ireland were formerly unable to compete, and against which they were protected in the home market by high duties on importation.

Of the flax-spinning mills there is one at Leeds, belonging to Messrs. Marshall, which ranks among the largest factories in the world. One particular room is, we believe, the largest in existence devoted to manufacturing purposes; it covers two acres of ground, the roof is supported by fifty pillars, and lighted by sixty-six large conical sky-lights.

The flax reaches the spinning-mills in small bundles of a few pounds each. The fibres are first *scutched* out at the ends, by a machine which subjects them to a sort of combing action. They are then *broken* into three pieces each, the middle section being the best in quality. They are next *heckled*, or separated, straightened, and cleaned; this used formerly to be done with the heckle, a sort of large comb with iron teeth; but it is now effected by a rotating machine, on the periphery of which the flax is fixed, and drawn against or between a series of sharp teeth. The fibres pass through six heckling machines in succession, each having finer teeth than the one which preceded it. The heckled flax is then sorted into portions, according to fineness and other desired qualities. The next process, that of *drawing*, connects the short fibres of flax into one continuous sliver or riband, nearly in the same way as the carding process described in COTTON MANUFACTURE; the flax is doubled and carded over and over again, until it presents the appearance of a smooth and glossy band, about an inch in width. When flax has been so far prepared, all the good portion receives the name of *line;* while the irregular, short, and defective fibres become *tow*. The tow is, however, susceptible of being drawn, doubled, carded, and spun into yarn of coarse quality. This tow is not the very rough substance usually known by the name; the latter is the refuse of hemp. The heckled slivers of flax are next *roved*, or converted from a flat riband to a soft small cylindrical cord. The *spinning* is the next process; this is done on the bobbin and fly principle, and the flax requires to be wet while under the process, thereby differing from cotton, wool, and silk. The flax used formerly to be wetted with cold water; but it is now found that finer yarn can be produced when warm water is used. The essential parts of the apparatus are shown in skeleton in *fig.* 3.

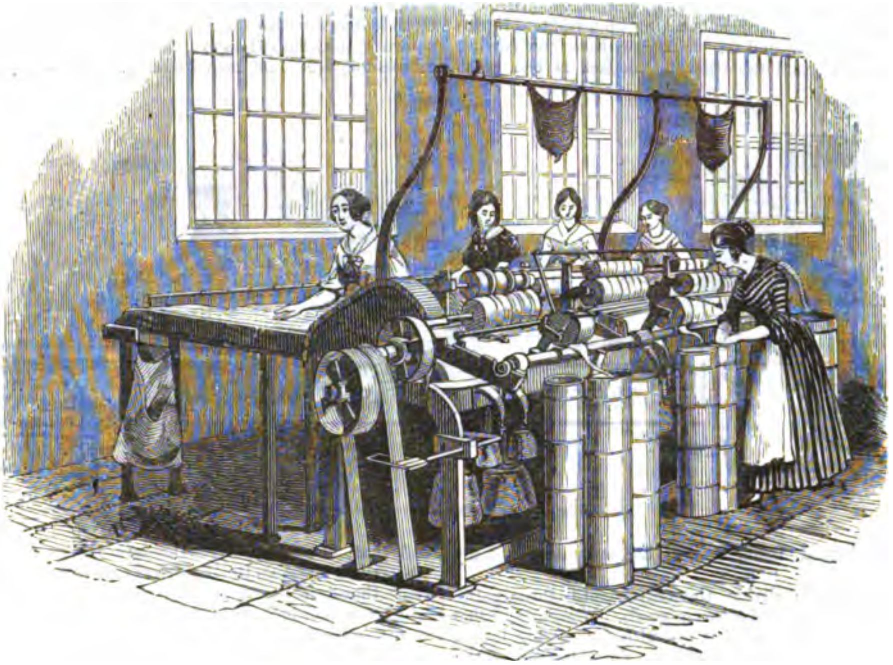


Fig. 1.—Flax Drawing.

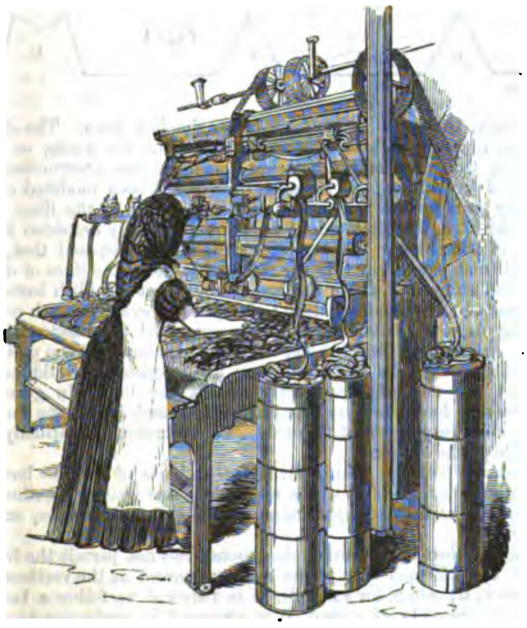


Fig. 2.—Tow Carding.

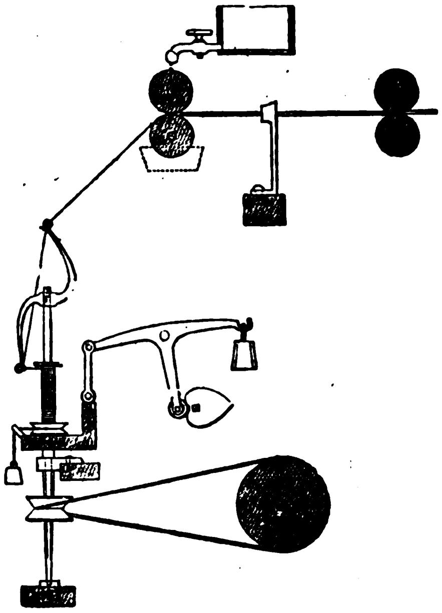


Fig. 3.—Wet Flax Spinning.

The spun yarn is applicable either for making thread or for weaving into linen goods. The quality of flax yarn is denoted by numbers describing the numbers of *leas* (a measure of 300 yards) contained in each pound weight. Thus a pound of No. 60 yarn measures 60 leas or 18,000 yards; No. 5 has only 1500 yards to the pound; while No. 200 has as much as 60,000 yards. Flax yarn is seldom spun of greater fineness than No. 200, which is fitted for making cambric of good quality. The improvements effected in the manufacture have greatly increased the average fineness and lowered the price.

More flax is spun in Leeds than in any other town; but the weaving is carried on elsewhere. In and around Barnsley are woven linen, duck, check, drabbet, tick, huckaback, diaper, drill, towelling, and other kinds of flax goods. Dundee is famous for sailcloth, dowlas, sheeting, and other strong textile goods; and Aberdeen is taking up a position in the same department. Dunfermline and its vicinity produce finer fabrics, such as shirtings, damasks, and table-cloths. Belfast is the great centre for good linen, and for the finer kinds of textile goods. Of these, duck is made in widths from three to five quarters of a yard; drill is a twilled linen, white or coloured, mostly used for summer trowsers; sheetings are known in the trade by the names of Irish, Russia, Imitation Russia, Lancashire, Yorkshire, Union Irish, and Union Lancashire, (the union cloth having a mixture of cotton with the flax); some of the sheetings are mostly or partly of hemp; damask is noticed under DAMASK; diaper is a figured fabric of lower quality; huckaback is a durable and economical kind of towelling. The best cambric is imported from France. Silesia is a sort of fine holland, used for window blinds. It may be stated here that many of the above-named fabrics are made either of flax or of hemp, according to the prices at which they are to be sold. The broad and well-made fabric for sailcloth is dressed with starch or flour before weaving, by the machine shown in the annexed cut; indeed most kinds of flaxen and hempen fabrics require some such dressing. The wet yarn, by passing over and under two steam-heated metal boxes, becomes very quickly dried.

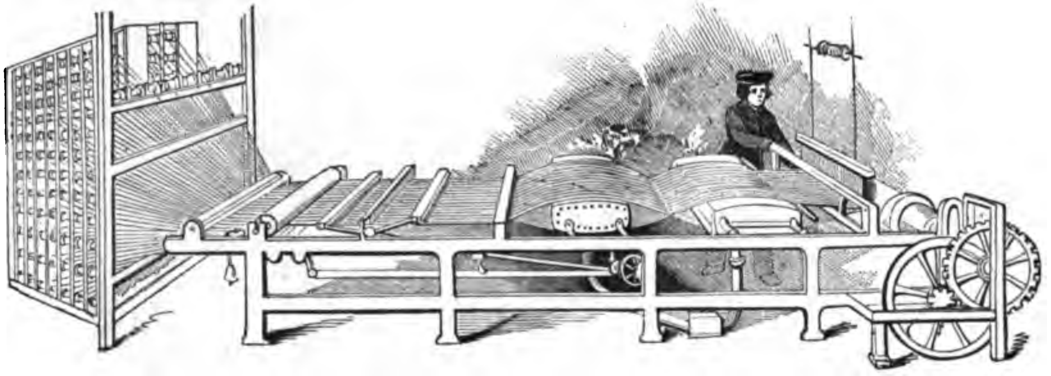


Fig. 4.—Dressing Yarn for Sailcloth.

The statistics of this trade divide themselves into three parts, relating to the seed, the fibre, and the woven goods. About 4,000,000 bushels of linseed are imported annually; one-fifth for sowing into a flax-crop, and four-fifths for pressing linseed-oil. Three-fourths of the whole supply is from Russia; the sowing-seed is very carefully prepared, and is imported in casks officially branded; but the crushing-seed is coarser, and is imported either in bulk or in mat-bags. The flax imported in 1844 was about 1,600,000 cwts., in 1850 about 1,800,000 cwts., and in 1858 about 1,300,000 cwts.; the quantity varying considerably in different years. The price has varied still more widely, depending chiefly on the Russian crops. The computed value of the seed and fibre imported in 1858 was 2,700,000*l.* The woven linen goods, taking that term in its widest acceptation in reference to kind and quality, varied from 14*d.* to 21*d.* per yard on an average in the years for 1835 to 1853; in later years it has generally been near the lower of these two limits. In respect to woven goods, the bounties allowed on the shipment of linens were graduated according to their quality and value, and ranged from a halfpenny to a penny halfpenny per yard. In 1825 the rates were diminished one-tenth by an act then passed, and an equal proportion was to have been taken off in each subsequent year, so that the whole would have ceased in 1834; but by the act of 1828, when one-half the bounties had been removed, this course was modified by continuing for three years the rates of allowance payable in 1829, and thereafter repealing the bounty altogether; so that the payments ceased in 1832. Since then the export trade has rested on its own resources. In 1828 the declared value of the exports of these goods was 2,100,000*l.*; in 1837 it was 2,500,000*l.* In 1844 the exports (white or plain linen, printed and dyed flaxen goods, sailcloth, thread, and yarn) reached a value of 4,000,000*l.*; in 1850, 4,800,000*l.*; and in 1858, 5,900,000*l.* The quantities in the last-named year were, 120,000,000 yards of piece goods, and 35,000,000 lbs. of thread and yarn. The import of woven flaxen goods is very small. The export to France steadily increased until 1842, in which year the French government, influenced by a demand for protection, raised the import duty considerably; and the English trade in this commodity has suffered ever since. The flax and linen manufacturers of England are hoping for an extension of their dealings with France, consequent on the new treaty of commerce (1860). The number of mills and operatives engaged in this trade, in the United Kingdom, is noticed under FACTORIES.

LINES, in Music, are the five parallel lines forming, together with the intermediate spaces, the staff on which the notes and other characters are placed. [STAFF; LEGER.]

LINES OF INTRENCHMENT. In the article ENCAMPMENT it has been stated that armies in the field are not now, as formerly, surrounded by fortifications consisting of a continuous line of works; and that, in general, a few breastworks or redoubts merely are constructed at intervals for the defence of the position. It will be sufficient, therefore, leaving out the consideration of those means of defence which are afforded by the natural obstacles of the country, as escarpments, rivers, marshes, &c., to describe briefly the nature of those intrenchments which were once, in all circumstances, considered indispensable, and which are still, to a certain extent, necessary when an army is to remain strictly on the defensive.

In the first place it may be said that a continuous breastwork would be advantageous for the protection of portions of a frontier, when the absence of natural obstacles might favour the enemy's marauding parties in making inroads for the purpose of levying contributions or laying waste the country; a parapet A B, broken by the redans C, C, from whence the defenders may annoy the enemy in flank on his approach, termed a Redan Line, is the simplest form. The distances of the redans from one another may be about 150 yards, or not exceeding the range of musket shot: such was the construction recommended by Vauban, and since his time, it has been modified occasionally by giving to the curtains the form indicated by the lines *a c*, *b c*, in order that the ditch might be more effectually defended from the faces of the redans. All the faces should be so disposed that, if produced to an extent equal to the range of artillery, the lines of direction may fall on ground where the enemy could not establish batteries for the purpose of enfilading them; since, in the event of such enfilading taking place, the defenders would be compelled to abandon the parapets; artillery, if placed there, would be dismounted; the palisades in the ditch would be destroyed; and little resistance could be made, should the enemy subsequently assault the line. In general the redans may have the form of equilateral triangles, and the lengths of their sides may be about 50 yards. The entrances are usually in the middle of the curtains.

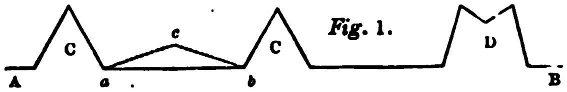
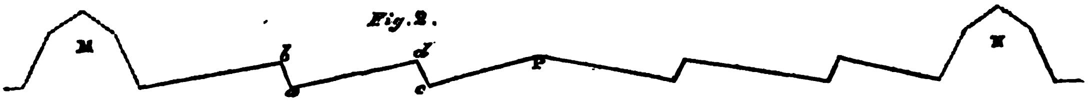


Fig. 1.

Instead of simple redans the advanced parts of the line have occasionally been formed of works resembling two united together, as D; which by the French engineers are called *queues d'hyrondes*, or double redans.

Again, when the nature of the ground does not permit the intrenchment to be formed with points so far advanced as the vertices of the redans C, C; when, for example, it is required to follow a bank of a river or one side of a road, it is proposed, in preference to a simple straight or curved line, to form the parapet with a series of branches in the positions indicated by *a b*, *c d*, &c., to P. A line of this kind is said to be *à crémaillières:* and in such situations a succession of fires from the branches *a b*, *c d*, &c., may be directed against the enemy during his advance; on a level plain however the longer branches would be subject to the serious defect of being easily enfiladed. The distances between the salient points *b*, *d*, &c., should not exceed 100 yards, and the lengths of the short branches may be about 18 or 20 yards. The re-entering angles *a*, *e*, &c., should contain about 100 degrees; and the entrances are usually placed at those points.

Fig. 2.



A like construction may be adopted when it is required to connect two points, as M and N, by a line along a narrow and elevated ridge of ground; and in this case the directions of the branches *b c*, *d e*, &c., may change in the middle of the line, as shown in the figure, in order that the fire from the long branches may be directed to the front of the nearest works, as M and N, in which it is to be supposed that artillery would be placed for the purpose of defending the ground before the intermediate line.

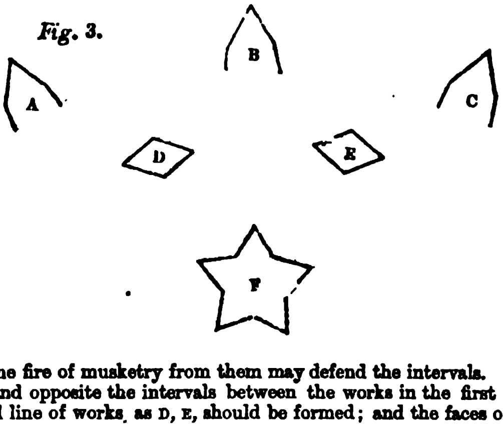
It may be added also, that the line *à crémaillières* (indented line) is convenient when it is required to join forts on hills or rising ground.

The most perfect fortification for defending a line of country presenting few natural obstacles to the advance of an enemy, should the importance of the position render it advisable to incur the labour of the construction, would be a series of bastions connected by curtains, either straight or broken. The principles on which the several *fronts of fortification* should be formed correspond to those adopted for regular fortresses, which are described in the article FORTIFICATION; the only difference being in the lengths of the several parts. These depend upon the whole length of the front, which here should not exceed 180 yards, that the ditches of the bastions may be well defended by common muskets from the collateral flanks. Neither ravelin nor covered-way would of course be necessary.

Lines of intrenchment composed of works placed at intervals from one another, provided the distances be not so great as to prevent the troops in them from mutually assisting each other, have great advantages over those formed of continuous lines of parapet. In the latter case it is scarcely possible for the army to make a movement for the purpose of attacking the enemy however favourable the opportunity, since much time would be lost in issuing from the line through the narrow passages; and as these are the objects against which the fires from the enemy's batteries would then be incessantly directed, it would be almost impossible to form any extended front for attack; besides which, the enemy penetrating at any one point the whole line is turned. Detached works, on the other hand, constitute a number of strong points by which the position of the army is secured; while through the spacious intervals an advance or retreat may take place with the utmost facility. Their artillery is conveniently situated for putting the enemy's line in disorder previously to the attack, and for protecting the retiring columns in the event of their quitting the field. It may be added that detached works are capable of being easily adapted to any kind of ground; for it is merely necessary to place them on the more elevated spots in such situations that the enemy may not be able to penetrate between them without being exposed to their fire.

On level ground the intrenchment may consist of a number of redans, as A, B, C, with or without flanks, disposed on a right line or curve, and at distances from one another equal to about 300 yards, that the fire of musketry from them may defend the intervals. In the rear, and opposite the intervals between the works in the first line, a second line of works, as D, E, should be formed; and the faces of these should be disposed so as to flank the ditches and approaches to the others. The gorges of the exterior works should be open, as in the figure, or only protected by a line of palisades, which, in the event of the enemy gaining possession of those works, might be destroyed by the artillery in the second line.

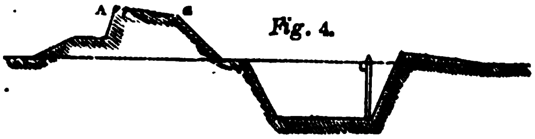
Fig. 3.



Instead of a series of redoubts forming an interior line, it may suffice, should the works A, B, C, &c., be disposed on a convex arc, to have one large central redoubt as F, so situated as by its artillery to defend both the intervals between the redans and the ground within their line.

All the works which have been described consist of parapets formed of earth obtained by cutting a ditch in front; and the profile of any one work with its ditch is shown in the subjoined figure (4).

Fig. 4.



The elevation of the crest A above the natural ground is about 7½ feet, unless the vicinity of a commanding height in front should render a greater relief necessary, and the depth of the ditch may be the same. The thickness A *a* of the upper part of the parapet is variable, and depends upon the importance of the work, or rather, upon the arm which may be employed in the attack: if it were required only to resist a fire of musketry, 3 feet would suffice; but from 8 feet to 12 feet would be necessary in the event of artillery being brought against it. (Twelve-pounder shot is the heaviest which the French have ever yet employed in the field.) The form of the parapet is the same as in permanent fortification; when time permits, the exterior and interior slopes should be revêted with sods, and a line of palisades should be planted along the foot of the counterscarp.

LININ, a crystalline substance of unknown composition found in the mountain flax (*Linum catharticum*).

LINOLEIC ACID. [OLEIC ACID.]

LINOLEIN. [OLEIC ACID.]

LINSEED (*Graine de Lin*, French; *Leinsaat*, German; *Lynsaad*, Dutch; *Linaza*, Spanish; *Linhaca*, Portugal; *Linseme*, Italian; *Semjalenjanve*, Russian), the seed of the Lin, Linum, or flax plant, is a valuable product derived from the capsules of *Linum usitatissimum*, and consisting of small grayish-brown lenticular bodies, containing a mealy albumen, of so oleaginous a nature, that it yields by pressure in great abundance the oil of linseed. The seed of the flax-plant is harvested not merely with a view to the reproduction of the plant, but also because of the oil which it yields by compression. For both these purposes, of sowing and crushing, linseed is largely imported into the United Kingdom. [LINEN MANUFACTURE; FLAX.] It is largely used now as cattle food—and the refuse, after its oil has been expressed, is the well-known oilcake of the cattle feeder.

LINSEED-OIL may be procured by cold expression of the seeds, a process which makes the oil clearer; or the bruised seeds are roasted in the oil-mills, in which case it is brownish-yellow, and easily becomes rancid, probably from attracting oxygen. Linseed-oil is pellucid, with a faint but peculiar odour and taste, generally disagreeable, from being subrancid. Specific gravity 0·93. It easily dries: by reduction of temperature it merely becomes cloudy, but scarcely freezes.

It may easily be purified by repeated agitation with water, by bleaching in the sun, or, better, by filtering it through newly prepared charcoal.

By long boiling it becomes dark-brown, tenacious, and thickened, but dries more easily, and in this state is used for printers' ink; by still longer boiling it becomes black, almost solid, and elastically tenacious, like caoutchouc, and in this state it serves for bird-lime.

By the addition of nitrous acid it becomes thick and red, then dark reddish brown, like tincture of iodine, but does not become solid. It is frequently adulterated with rape-oil, which may be detected by this test. Neither does it form elaidin, as rape-oil does. But a simpler test is, that if wood be smeared with oil which has been adulterated, it does not become dry.

Linseed-oil is used to form liniments, of which the most common is that with lime-water, as an application to burns. But it is much more extensively used in the arts, particularly for painting. It is mildly laxative.

LINT. [LINUM USITATISSIMUM.]

LINUM USITATISSIMUM, *Medical Properties of*. The seeds of this plant yield several articles useful in medicine and surgery. The testa, or husk of the seeds, is very mucilaginous, the kernel contains much oil, and the farina or meal, procured by grinding or bruising the seeds, after the oil has been expressed, furnishes an excellent material for poultices, but now greatly superseded by Spongiopiline. [CATAPLASMS.] The seeds are oblong-ovate, acute, compressed, brown, shining, very smooth, the skin thin, the kernel white and oily. They are devoid of odour, but have an unpleasant mucilaginous oily taste. Old, rancid, and corroded seeds should be rejected. One part of seeds and two parts of water yield a strong mucilage. It is much better to obtain the mucilage by merely pouring cold water on the entire seeds, than to bruise them and pour boiling water on them, as generally directed. The mucilage is analogous to that of the quince seed [Cydonia in Nat. Hist. Div.], and differs in its chemical habitudes, in several respects, from common gum. The compound infusion of linseed is demulcent, and the unpleasant taste may be much lessened by using cold water to form it, as stated above. The farina of the seeds, ground before the oil has been expressed, furnishes the best material for poultices, but does not keep well. The cake remaining after the expression of the oil is much used to fatten cattle, but gives a peculiar taste to the meat.

The lint, or charpie, used by surgeons to dress ulcers, &c., should always be prepared from linen-cloth and never from cotton, as an essential difference exists in the nature of their fibres, which causes that of cotton to prove extremely irritating.

LIP. [Hare Lip.]

LIPIC ACID. [Succinic Acid.]

LIPRYL, a name formerly applied to the radical of glycerin. [Glycerin.]

LIQUEFACTION. When heat is supplied in sufficient quantity to a solid body, it changes its form and becomes liquid. When this change takes place in the case of ice the process is called *liquefaction*, but in the case of metals *fusion*. So also if heat be abstracted in sufficient quantity from a liquid, it usually becomes solid, which process, in the case of bodies which under ordinary circumstances are liquid, such as water, oil, &c., is called *congelation*; but for bodies which are usually solid, such as the metals, the process is called *solidification*.

The more important phenomena attending liquefaction are stated under Latent Heat. [See also Freezing Mixtures; Heat.] Bodies require very various amounts of heat for liquefaction. Mercury, for example, fuses at 39° below zero, wrought iron above +3280°. The following table contains the fusing points of the substances named:—

Names of Substances.	° Fahr.	Authority.
Mercury	—39	Hutchins.
Oil of vitriol	—30	Regnault.
Bromine	+ 9·5	Pierre.
Ice	32	
Phosphorus	111·5	Schrötter.
Potassium	136	Regnault.
Yellow wax	143·6	Person.
Sodium	207·7	Regnault.
Iodine	224·6	Gay Lussac.
Sulphur	239	Person.
Tin	451	
Bismuth	512	
Nitrate of soda	591	
Lead	620	
Nitrate of potash	642	
Zinc	773	Daniell.
Antimony (about)	900	
Silver	1773	
Copper	1996	
Gold	2016	
Cast-iron	2786	
Wrought-iron	above 3280	

The fusing points of alloys are often much lower than the fusing point of either of their components. An alloy of two parts bismuth, one of lead, and one of tin, fuses at 200°. The alloy of eight parts bismuth, five of lead, and three of tin, fuses a little below 212°: the addition of one part mercury renders it still more fusible. It is a very convenient substance for taking casts. When this *fusible metal*, as it is called, is poured upon a marble slab, and broken as soon as it is cool enough to be handled; its surfaces are bright and conchoidal, but the metal is very brittle. Soon, however, it becomes very hot, ceases to be brittle, and the fractured surface becomes granular and dull; this change of temperature must arise from some new molecular arrangement of the particles after solidification; it does not appear to be due to the evolution of latent heat, arising from the solidification of the interior after that of the exterior crust, as has been suggested. The metal after falling to 90° has been known to rise to 150°. The use of fluxes by the metallurgist and others affords numerous illustrations of the fact that mixtures of various bodies fuse at lower temperatures than their component parts do separately. Mixtures of various salts illustrate the same fact:—thus, nitrate of potash fuses at 642°, nitrate of soda at 591°, but a mixture of the two salts in equivalent proportions liquefies as low as 429°.

Under the combined influence of pressure and cold most of the gases have been liquefied and even solidified as noticed under Gases, Liquefaction of.

LIQUEFACTION OF GASES. [Gases, Liquefaction of.]

LIQUIDITY is that condition of a material substance in which the particles have a perfect freedom of motion, without any sensible tendency to approach to or recede from one another, except by the action of some external power. Liquidity is therefore comprehended in the condition of fluidity, the latter term being applied as well to gases, and even to the principle of electricity, magnetism, &c., as to water, oil, &c., which are properly called liquids. [Fluid; Fluidity.]

The phenomena of capillary or molecular action show that the attractions which constitute what are called the *affinities* of substances extend to very small distances only from the particles; and hence, when the particles of a substance are situated beyond the limits of such attractive forces, the repulsive power, arising probably from the action of caloric, causes the particles to recede continually from one another, and induces the state of aeriform fluidity. [Attraction.] Now the phenomena of crystallisation seem to indicate that the attraction of affinity is exerted with greater or less intensity according as the like or unlike sides of the particles of a substance present themselves to one another in their mutual approaches; but it is probable that this modification of the attraction of affinity extends to less distances from the centres of gravity of the particles than the general attraction extends: hence, when the particles of a substance are, from any cause, brought so near one another that the attraction of affinity is in equilibrio with the repulsive force of the caloric, and at the same time the modification of that attraction caused by the various positions which the particles assume in approaching one another, entirely or nearly vanishes, it should follow that the particles become freely moveable in any direction about one another, whatever be their form; and thus may arise the condition of liquidity.

It may be added that, if the particles of a substance be, by the abstraction of caloric, made to approach still nearer to one another, the attraction of affinity will exceed the force of repulsion; and there will be constituted a solid body, which may be crystallised or not according as the particles approach one another gradually or otherwise: in the former case they may arrange themselves in such positions as to become connected together in one direction by the sides at which the attraction is the greatest; while, if the approach is rapid and is accompanied by agitation, the union of the particles may take place irregularly.

The particles of a liquid are held together with considerable force notwithstanding their freedom of motion, since a small quantity of a liquid has a tendency to take a spherical form when at a distance from any substance for which its particles have greater affinity than for one another: this is very evident in mercury, oil, and water, the first of which on being suffered to fall on a table immediately divides itself into globules, and the others take a like form when a small quantity of either is suspended from a pointed extremity of any object.

The dilatations of water and mercury by the application of heat, as well as the remarkable fact that the expansions of water are equal at temperatures which are at equal distances above and below about 39° Fahr., will be noticed under Thermometer. See also Heat. But the expansions of any liquid, at different temperatures, for equal increments of caloric, are not equal to one another; and indeed the same remark may be extended to solids, as shown under Heat. The phenomena of molecular action in liquids are noticed under Capillary Attraction, Diffusion, &c. See also Molecular Attraction, and for the specific heat of liquids, or their capacity for caloric, Specific Heat.

LIQUOR OF CADET. [Cacodyl.]

LIQUORICE. [Glycyrhiza.]

LIRIODENDRIN, a colourless, non-azotised, crystalline substance, found in the stem of the Virginian tulip (*Liriodendron tulipifera*). It is slightly soluble in water, but very soluble in alcohol and ether. Its composition has not been determined.

LIS PENDENS. [Notice.]

LIST, CIVIL. [Civil List.]

LISTING. [Enlistment.]

LITANY, a collection of prayers and supplications. The term is derived from the Greek (λιτανεία), and was adopted by Christian writers at a very early period. St. Basil tells us that Litanies were read in the church of Neocæsarea, between Gregory Thaumaturgus's time and his own: and St. Ambrose has left a form of Litany which bears his name, still used in Milan. In the early churches the Litanies were said in solemn procession.

In the Common Prayer Book of 1549 (the first book of King Edward), the Litany was placed between the Communion Office and the Office for Baptism, under the title of 'The Letany and Suffrages;' which book also directed it to be said or sung on Wednesdays and Fridays. In the review of the Common Prayer in 1552, the Litany was placed where it now stands, with the direction that it shall be used on Sundays, Wednesdays, and Fridays, and at other times when it shall be commanded by the ordinary. Till the last review, in 1661, the Litany was used as a distinct service, and followed the Morning Prayer; it was then directed and has ever since continued to be read as one office with the Morning Prayer, after the third Collect for Grace.

LITHARGE. [Lead: *Lead and Oxygen.*]

LITHIA (LiO). The alkaline base formed by the union of lithium with oxygen. It unites with acids to form an extensive class of salts. [Lithium.]

LITHIC ACID. [Uric Acid.]

LITHIUM (L). In its chemical relations this metal more nearly resembles the alkali metals, potassium and sodium, than any others; but it is a kind of connecting link between that group and the next, or metals of the alkaline earths (barium, calcium, &c.) Its existence was first pointed out by Arfwedson (1817), who discovered its oxide when examining a mineral in the laboratory of Berzelius. Its name is derived from λιθος, a stone, it having been found in the mineral kingdom only.

The principal sources of lithium are the minerals *lepidolite*, *triphane*, and *petalite*. A table of their per-centage composition is given under the respective names in the Nat. Hist. Div. Their formulæ is thus represented in Miller's 'Elements of Chemistry:'—

Lepidolite or lithia mica .	$2[(LK)\,Fl]+4(Al_2O_3,\ 3\ SiO_3)$
Triphane or spodumene .	$3[(LNa)O,\ SiO_3]+4(Al_2O_3,\ 3SiO_3)$
Petalite	$3[(LNa)O,\ 2SiO_3]+4(Al_2O_3,\ 6SiO_3)$

Lithium may be obtained in the metallic state by decomposing its chloride with an electric current generated from five or six pairs of Bunsen's nitric acid battery. It is a white metal, harder than potassium or sodium, but softer than lead. It melts at 356° Fahr., and is not volatile when heated to redness. At common temperatures two pieces may be welded together by pressure. It can be drawn into wire, but is less tenacious than lead. Its specific gravity is 0·5936, hence it is the lightest solid body known; it floats even on the surface of naphtha. It rapidly oxidises in the air, and if assisted by heat burns with a brilliant carmine-tinted flame. It decomposes water in a similar manner to sodium, and ignites when placed in strong nitric acid.

The equivalent of lithium is 6·53.

Lithium and *oxygen* form but one compound, namely:—

Oxide of lithium (LO). The mineral from which it is to be extracted is reduced to an almost impalpable powder, and then ignited with twice its weight of quicklime in a silver crucible. The resulting mass is next treated with hydrochloric acid, then with sulphuric acid, and the sulphate of lithia thus formed dissolved out from sulphate of lime by washing with water; a small quantity of oxalate of ammonia is now added to remove lime that may have been dissolved, and sulphuric acid thrown out of solution by the addition of baryta water. On evaporating the filtered liquid the lithia separates out in grains. If necessary, it may be fused in a silver crucible, vessels of platinum being rapidly corroded by it.

Hydrate of lithia is not so soluble in water as the hydrates of potash or soda are. It has a strong caustic taste, and turns vegetable reds to blues. In the fused state it is white, transparent, has a crystalline structure, does not deliquesce in the air, and dissolves in water with disengagement of heat.

Lithium and *chlorine* form:—

Chloride of lithium (LCl). It is readily made by dissolving the oxide in hydrochloric acid. On evaporation the solution yields cubical crystals, very soluble, exceedingly deliquescent, and containing four equivalents of water of crystallisation.

Iodide of lithium (LI + 6HO) crystallises in needles, and *fluoride of lithium* in small opaque grains.

Sulphide of lithium is formed in the same way as sulphide of sodium, and much resembles that compound.

Sulphate of lithia ($LO,SO_3 + Aq$). On evaporating the solution of this salt, obtained as described under *oxide of lithium*, tabular crystals of the above composition are obtained.

Carbonate of lithia (LO,CO_2) is precipitated when carbonate of ammonia is added to a strong solution of chloride of lithium. It may be washed with alcohol, in which it is insoluble. It is slightly soluble in water, the resulting solution having an alkaline reaction. On the application of heat to the dried salt it fuses, and solidifies on cooling to a white transparent mass of pearly lustre and crystalline fracture.

Carbonate of lithia has been recommended to be administered as a solvent for calculi in the bladder. It certainly effects the solution of uric acid most rapidly when triturated with that substance in a mortar containing a little water; but as many calculi do not contain uric acid, and as most of those that do contain it have an external coating of phosphates, it follows that the carbonate of lithia, being an alkaline substance, may do more harm than good if administered indiscriminately.

Double phosphate of lithia and soda.—When phosphate of soda is added to a solution of a lithium salt no precipitate is at first produced; but on evaporating to dryness the above compound remains as a white powder, almost insoluble in water, and quite insoluble in dilute aqueous solutions of the alkaline phosphates. Before the blowpipe, with carbonate of soda, the double salt fuses to a clear bead, transparent when hot but opaque when cold. A fused specimen examined by Berzelius contained NaO,LO,PO_5, but generally its composition is very variable, probably on account of the two bases, lithia and soda, being capable of replacing each other.

Tests for lithium.—Salts of lithium are readily fusible in the blowpipe flame, imparting to it a carmine red colour, and attacking the platinum wire holder or other platinum vessel in a characteristic corrosive manner. Their presence is further confirmed by forming the carbonate and double phosphate in the way already mentioned.

LITHOFELLIC ACID. ($C_{40}H_{36}O_8$). *Lithofellinic acid.* The once celebrated *bezoar-stones*—intestinal calculi of certain animals—almost wholly consist of this acid. To isolate it, the stones [Bezoars], are reduced to powder and boiled in alcohol, the dark solution decolorised with animal charcoal and evaporated, when the lithofellic acid crystallises out in small, colourless, transparent six-sided prisms. It may also be decolorised by precipitating its alkaline solution with hydrochloric acid, washing, drying, and crystallising from alcohol.

Lithofellic acid is insoluble in water, slightly so in ether, and very soluble in alcohol. Heated to 401° Fahr. it melts, and at a little higher temperature is converted into a resin, the fusing point of which is only 230° Fahr. In this particular, and in the fact that it is readily soluble in solutions of the alkalies and their carbonates and in acetic acid, lithofellic acid is easily distinguished from cholesterin, a body that otherwise it much resembles.

Submitted to dry distillation, it yields an oily acid, termed *pyrolithofellic acid* ($C_{40}H_{34}O_6$).

Lithofellic acid combines with bases to form *lithofellates*, a class of compounds that have not been much studied. The silver salt appears to contain $C_{40}H_{35}Ag\ O_8$.

LITHOGRAPHY, the art by which impressions or prints are obtained by a chemical process from designs made with a greasy material upon stone. It has therefore been properly termed chemical printing, to distinguish it from all other modes of obtaining impressions, which are mechanical. In printing from an engraving on a copper or steel plate, the ink is delivered from the incisions made therein with the graver or etching-needle. An engraving on wood, on the contrary, gives its results from the projecting surface of the block, or those parts which are not cut away by the graver. The lithographic process differs from both these modes, the impressions being obtained (by strict attention to chemical affinity) from a level surface. The art of lithography was first practised by the inventor Alois Senefelder, in 1798, the peculiar property on which it depends having being discovered by him a few years earlier. [Senefelder, Alois, in Biog. Div.]

There are various styles of lithography, as will presently be seen; but the principle of the art is uniformly the same, being, as we have said, based upon that of chemical affinity.

The stone best calculated for lithographic purposes is a sort of calcareous slate, found in large quantities on the banks of the Danube in Bavaria, the finest being that found at Solenhofen, near Munich. Stones much resembling the German have been found in some parts of Devonshire and Somersetshire, and also in Ireland; but the stones found in this kingdom have been proved to want some of the essential qualities of those brought from Germany, which are therefore, at least for artistic works, exclusively used. Even the Bavarian stones vary much in quality, all the strata not being equally good: some are too soft, and others are rendered unfit for use by the presence of chalk, flaws and veins, and fossil remains. A good stone is porous yet brittle, of a pale yellowish-drab, and sometimes of a gray neutral tint. The stones are split or sawn into slabs varying from 1¼ to 3 inches in thickness, which are then cut or squared into the different sizes necessary for use, and the face or upper surface of each is made level. In this state are the stones sent from the quarry; but further preparation is yet necessary to fit them for the immediate use of the artist, and they are either grained or polished, according to the nature of the work they are intended to receive. The mode of preparing a grained stone, as it is called, is this:—A stone, being laid flat on a table, has its surface wetted, and some sand sifted over it through a very fine wire-sieve. Another stone is laid with its face downwards upon this, and the two are rubbed together with a circular motion, to produce the requisite granulation, which is made finer or coarser, to suit the taste or intention of the artist. The stones thus prepared are used for drawings in the chalk manner, or for imitations of those produced with the black-lead pencil. Great care is requisite in this mode of preparation, to keep the granulation uniform and the surface free from scratches, the presence of which would otherwise much disfigure the future work. Writings, imitations of coloured drawings, etchings, pen and ink sketches, &c., require the face of the stone to be polished, which is effected by rubbing it with pumice-stone and water, or pumice stone dust and water applied with rags.

The two principal agents used for making designs, writings, &c., on stone, are called lithographic chalk and lithographic ink. They are composed of tallow, virgin-wax, hard tallow soap, shell-lac, sometimes a little mastic or copal, and enough lampblack to impart a colour to the mass. These are incorporated by a peculiar process of burning in a closely-covered saucepan over a fire, and the whole is ultimately cast into a mould, and receives the form calculated to fit it for use. The ingredients are the same in the chalk and the ink, but the proportions are varied, and a little Venice turpentine is often added in the latter. The chalk is used as it comes from the mould in a dry state, but the ink is dissolved by rubbing, like Indian ink, in water, and is used in a pen or camel-hair pencil. It will be perceived that it is the presence of the soap in this greasy material which renders it soluble in water.

To render the lithographic process intelligible, let it be supposed that the artist now completes a drawing with the chalk just described, upon a grained stone, much as he would make a drawing in pencil or chalk upon paper. If, while in this state, a sponge filled with water were passed over the face of the stone, the drawing would wash out, the chalk with which it is made being, as we have seen, soluble in water, by reason of the soap which it contains. Before therefore it is capable of yielding impressions, a weak solution of nitreous acid is poured over it, which unites with and neutralises the alkali or soap contained in the chalk, and renders it insoluble in water. After this the usual course is to float a solution of gum over the whole face of the stone, and when this is removed, if a sponge and water be applied to its surface, as before supposed, the drawing is found to be no longer removable, because the chalk with which it is executed is now no longer soluble in water. In this state the work is ready for the printer, who obtains impressions by the following process.

Having with a sponge filled with water, to which an extremely small quantity of acid has been added, wetted, or rather damped, the whole surface of the stone equally, the printer finds that the water has been imbibed by the stone only on those parts not occupied by the drawing, which being greasy repels the water and remains dry. A roller properly covered with printing-ink is now passed over the whole stone, which will not even be soiled where it is wet, from the antipathy of oil and water. But the parts occupied by the drawing being, as we have seen, dry and greasy, have an affinity for the printing-ink, which therefore passes from the roller and attaches itself to the drawing. In this state it is said to be charged, or rolled in. Damped paper is then put over it, and the whole being passed through a press, the printing-ink is transferred from the stone to the paper, and this constitutes the impression. By repeating in this manner the operations of damping the stone and rolling in the drawing, an almost unlimited number of impressions may be obtained.

Now, as we have said, the modes of lithography are various, but the illustration just given will explain the principle of them all. It consists in the mutual antipathy of oil and water, and the affinity which the stone has for both, that is, in its power of imbibing either with equal avidity. But, as will be inferred, to ensure complete success, great nicety is requisite in the preparation of all the agents employed in this art, and in the process of printing, as well as in making the drawing on the stone.

Imitations of etchings or pen and ink drawings, writings, &c., executed with the chemical ink upon a *polished* stone, are prepared and printed in precisely the same manner.

Transfer lithography, or *Autography*, from the facility of its execution and its great utility, claims especial notice. A paper called *transfer-paper* or "autographic paper," is used to receive the writing in this mode of lithography. This paper has previously had a liquid gummy preparation washed over one side of it, which, when dry, constitutes its face, and the writing being performed with a modification of the chemical ink already described, rests upon this gummy surface, and does not penetrate to the paper beneath. When the writing or drawing done on the transfer-paper is dry, the back of it is wetted slightly but equally with a sponge and water; and the paper being very thin, the gum preparation on the front of it becomes at once partially dissolved. In this state the paper is laid, with its face downwards, on a *polished* stone, and being passed through a press, the transfer-paper is found strongly and closely adhering to it. The back of the transfer-paper is now well wetted, and, one corner being first raised, it will readily peel off, leaving the gum preparation, and of course also the writing which was above it, attached to the stone. The gum is then washed off with water, and the preparation and printing proceed in the manner already explained. This mode of lithography being eminently calculated to facilitate the despatch of business, its great utility has been sensibly felt in the commercial departments of the country and in several of our government offices, as by its means one written despatch can be multiplied at pleasure, without delay or the risk of typographical errors.

Another style of lithography is commonly called "*etching*," or "*engraving on stone*," although it must by no means be inferred that in this process the stone is incised, but that the results correspond with the clean-cut lines of the graver or etching-needle. A coat of gum-water, with some lamp-black or vermilion mixed with it, to give it colour and render the work visible, is thinly but evenly rubbed over a *polished* stone, and, when dry, effectually protects it from any application of grease. On this gum ground the design is executed with an etching-needle, precisely the same as in etching upon copper; and wherever the needle passes, of course the stone is laid bare, and it is best to cleanly remove the gum ground without cutting into the stone. After this some oil is rubbed over the whole surface, and is imbibed by the stone wherever the needle has passed and exposed its surface by removing the ground. The gum is then washed off, and the work may be at once rolled in and printed, without any previous acidulation.

Thus we see that grease anyhow applied to the stone will yield impressions, but that the character of the impression depends, 1st, on the *quality* of the grease; 2dly, on the *quantity* of grease; and 3dly, on the manner in which the grease is *applied*. As illustrations, we refer to the modes already enumerated, in which the application of the chemical preparation in the shape of a *solid chalk*, of *fluid ink*, and of *pure oil*, directly applied to the stone, have been pointed out, and the effects arising from each explained. It is the grease therefore which prints, and the lampblack introduced into the lithographic materials is of no other use than to enable the artist to judge of the quantity of grease imparted to the stone. That it does not in the slightest degree contribute to produce greater darkness in the impression, is proved by a very curious phenomenon. The design may be (and often is, in the progress of printing) washed out with turpentine, so as to become quite invisible; and a looker-on, unacquainted with the subject, would suppose the work to be completely destroyed; but it is the *black* only which has disappeared; the *grease* remains, and on being rolled in again, the drawing re-appears uninjured.

The variation in the quality of the tints, arising from the mode in which the grease is applied, may be further illustrated by reference to the *dabber*, which is an instrument by which tints of exceeding delicacy may be produced. It is made of very smooth leather, being somewhat round on its face, and stuffed with cotton wool. On the face of the dabber a lithographic preparation, softer than the chalk, is evenly and thinly applied with a hard brush, and afterwards imparted to the stone by repeated blows with the instrument. The dabber was formerly much in use, particularly for delicate skies; but as lithography has been longer cultivated among us, our artists have acquired greater manual dexterity, and produce tints of the greatest delicacy with the hand alone, which have the recommendation of standing better than those produced with the dabber. Another mode of applying the greasy material, which was introduced some years back, and was found in skilful hands to produce very effective results, was by means of a stump, as in crayon drawing [Crayons], to which the process is very similar. Again, with a modification of the ink already described, drawings were made by washing, or laying in tints, with brushes (or camel-hair pencils) much as drawings are ordinarily made with India-ink or sepia. By both these means almost perfect fac-similes of artists' sketches may be produced: indeed, as is evident, lithography admits of any mode of manipulation which may suit the habits, taste, or style of the artist, so that it be consistent with the main principle of the art.

The printing from two or more stones, which was practised with indifferent success almost in the earliest stages of lithography by Senefelder and others, has within the last few years been very extensively practised. In this style, when all that is desired is to imitate a drawing made on tinted paper, with the high lights laid on with white, the drawing is first made in the usual way, with chalk on a grained stone, but more slight, the sky and other delicate tints being omitted, and these are superadded from the "*tint stone*." The tint is executed with facility by the printer on another stone (polished), with a modified preparation of chemical ink, and thus much labour is saved to the artist. The extreme lights are then scraped out on this tint stone, and the printer superadds the impressions from it to those already taken from the drawing on the other stone; of course taking great care that the two fit well, or "*register*," as it is technically called.

But the most important application of this process is in the production of copies of coloured drawings and paintings; a process known as *chromo-lithography*. The object here being to produce as nearly as possible fac-similes in colour, touch, and texture, as well as in drawing and light and shadow, of pictures from the pencils of painters of the highest standing, it has been found necessary to employ a large number of stones, in order to produce the almost infinite varieties of tints which are found united in a single picture; every stone giving a separate impression in its own particular colour or tint. The mode of procedure is somewhat as follows. First, an outline of the entire subject is made by means of transfer paper, or otherwise, on a stone which is called the outline or key-stone of the work. This stone yields impressions which are transferred as guides to all the other stones. On a second and third stone which serve as the basis of the print the general effect of the drawing is washed in, and from these are printed what may be called the chiaroscuro, in a faint tint of sepia and of a neutral-colour or gray: corresponding in fact very nearly to the neutral or dead-colouring of a water-colour drawing in the method adopted by the early water-colour painters. The stones which follow are each charged with a particular colour or tint, and each leaves its impression on only a particular portion of the print: one stone printing only the parts which are intended to be yellow or a modification of yellow; another red, another blue, and so on. Other stones charged in parts with grays or secondary colours serve to blend and harmonise the crude colours; others follow which modify these, and finally, one gives the sharp dark touches, and is usually followed by another which supplies a sort of glaze or finishing wash, and subdues and harmonises the whole. Of course, we have only broadly indicated the general method. It will be understood that the sequence of the colours in the printing; the special quality and strength to be given to each particular tint; the effect to be produced by their superposition, and many other particulars, have all to be taken into account in planning, the arrangement of the colours on the stones; since a sequence in some respects different, and an entirely different modification of colours, have to be employed for the works of most artists; and it happens that much of the colour on each of the earlier stones is covered by that of succeeding stones, and that thus only can the broken tints of the original be imitated. It is in fact only by watching the progress of a print through all its stages that any clear idea can be obtained of the beauty and accuracy of the whole process, of the prevision that must be exercised, and of the skill, care, and taste required at every step to carry it to a successful termination. For some of the more elaborate prints—one or two after Turner, for instance—from thirty to forty stones have been required to produce a finished print. And in order to produce this print, it must be borne in mind that each sheet of paper has to be passed as many times through the press as there are stones, since each stone imprints upon it only its own particular section of the work. Of course, in proportion to the increase in the number of the stones, does the difficulty increase of making the work upon each fall exactly upon its proper place in the general design; for if any one were misplaced only the fiftieth of an inch, the drawing and colour of the whole would be disturbed. Hence it is found necessary to arrange the *register*, or adjustment of the stones, with the utmost care and precision; and to exercise the most careful supervision in the printing (which is entirely a hand process), since the sheet of paper expands considerably in passing through the press, and has to be dried and re-damped before it can be passed through again. But practically this is all accomplished with seeming ease, and a large and most complex subject will be found, when the last stage has been reached, to bear the most minute scrutiny; and the result, even when the copy is placed alongside the original, will surprise and delight equally those who have followed the work through its several steps, and those who may only examine the completed work.

Transfer lithography has been applied in other ways than the one already explained: indeed it would be difficult to fix limits to its capabilities, improvable as they may be in the hands of able chemists. Among the transfer modes, that of *printing copper-plate engravings from stone* is worthy of notice. An impression is taken on unsized paper from the copper-plate, and without delay transferred, by passing through a press, to a polished stone; it is then acidulated, and the printing proceeds in the usual way. In some kind of work the impressions thus obtained are scarcely distinguishable from those printed direct from the copper. The advantage which this application of lithography holds out is most apparent where economy or great despatch are important. These objects are both obtained by transferring impressions to several stones, or several impressions to one stone if the design be small, when the numbers can be multiplied with great rapidity, and without the original engraving being at all worn.

Plates of zinc are for some purposes much used as substitutes for the German stones, in chemical printing, and the practice is then called *Zincography;* but excepting the difference of the material on which the work is performed, it is precisely the same art as lithography. Zinc plates have the advantages of greater portability, and of being less liable to break from the pressure in printing.

LITHONTRIPTICS, termed also LITHONTHRYPTICS, or ANTILITHICS (λιθος, a stone, and τρίβω, to rub or bruise), medicines or other means which are thought to possess the power of dissolving stone or calculus in the urinary organs. The calculous concretions which are apt to form in the kidneys or bladder are of very different kinds, originating in different constitutions or in different habits of life or locality of abode. They are also different, not only according to the time of life when their formation began, but they often become varied in the progress of their increase, and are different in the strata of which they are composed.

It requires, therefore, not only very close investigation into the characters of the urine of a person supposed to be affected with calculous concretion, but also no slight acquaintance with the chemistry and physiology of that fluid, and the great influence of the nature of the food and drink on its composition, to be able to direct the use of medicines which are regarded as lithontriptic. With few exceptions, their employment has been nearly empirical; and aggravation of the case has as frequently resulted as benefit from their employment. The researches of recent chemists and pathologists have given something approaching to a scientific explanation of the circumstances under which calculi form, as well as of their varied characters; so that more good may reasonably be expected from the use of lithontriptics than has hitherto been realised. [CALCULUS.]

Of the twelve or thirteen varieties of calculus concretions which have been discovered in the bladder or kidneys of the human subject, some are of very rare occurrence, while the more common ones may be classed under two distinct heads—those which form under the prevalence of the uric or lithic acid state of constitution, and those which form under the prevalence of the phosphatic state of constitution. These sometimes alternate, and indeed the concretions which belong to the last class have almost invariably a nucleus or centre of the first kind, which shows how very important it is to avoid the causes of the lithic acid formations.

Independent of constitutional peculiarities, the leading causes of the formation of calculous concretions are errors in diet or regimen. The kidney is the great channel for the expulsion from the system of the azotised or nitrogenous principles of the blood, as well as of many saline particles, which were once an integral part of the body, but now effete; and to keep these in suspension, so as to ensure their elimination from the body, a due quantity of an aqueous menstruum is required. Hence whatever reduces the quantity of urine below the proper standard predisposes to the formation of calculi. Now an excess of animal food, particularly if exercise be neglected, and strong wines—in a word, rich living, with indolent habits—are the frequent origin of calculous complaints. Crude vegetables, with bad clothing and exposure to cold and damp, which interfere with the healthy action of the skin, equally predispose to the formation of stone, and thus the poor suffer from it as well as the wealthy. The causes being so widely different, the mode of treatment must also be different. A specific cannot therefore exist, and all unskilful tampering with a case must lead to most hurtful results. Medicines taken by the mouth (and such alone can be used where the stone is in the kidney) have been hitherto more successful in relieving the distressing symptoms than solvents thrown into the bladder. There is, however, ground for believing that in certain cases, under competent direction, chemical agents and perhaps galvanism may be made available to dissolve the concretions in the bladder. These agents are quite distinct from any mechanical means for crushing the stone.

(See Brodie, *Lectures on Diseases of the Urinary Organs*, 2nd ed.; and particularly the very excellent work of Dr. Willis, *Urinary Diseases and their Treatment*, 1838.)

LITHOTOMY (from λίθος, a stone, and τέμνω, to cut). Although urinary calculi may be extracted from the kidneys, urethra, or bladder, the term lithotomy is restricted to the operation of cutting into this latter viscus for the purpose of removing one or more stones. From the complex nature of the fluid secreted by the kidneys, and the quantity of saline matters which it holds in solution, deposits not unfrequently take place in one or other of the cavities to which the urine has access. Hence solid concretions, or urinary calculi, may be met with in the kidneys, ureters, bladder, or urethra; but the majority of these concretions are believed to be formed originally in the kidneys. Now, if we suppose one of these calculi to have descended into the bladder, it is easy to imagine that it would there form a nucleus, around which the addition of fresh matter would be constantly adding to its bulk: *à priori* reasoning would lead us to suppose such to be the result, and that this actually takes place is proved by the fact that many calculi have for their nucleus foreign bodies that have accidentally entered the bladder, as bullets, splinters of bone, bits of bougie, &c. The number and size of calculi met with in the bladder differ as much as their form and composition vary, and their magnitude is generally in an inverse ratio to their number. A case has been recorded in which 398 calculi, from the size of a pea to that of an olive, were found in the bladder after death; while, in a case described by the late Sir James Earle, a stone was extracted after death which weighed 44 ounces, its long axis measuring 16 inches, and the shorter 14; but the average size of vesical calculi is about that of a walnut. Their form is mostly spheroidal, or egg-shaped, and sometimes flattened on two sides like an almond. [CALCULUS.]

According to their composition, they are either soft and friable, or very dense and hard, and their surface may be quite smooth or beset with numerous tubercles. These circumstances, together with their loose or fixed position in the bladder, have considerable influence in determining the comparative severity of the symptoms. Children and aged persons are more subject to the disease than those in the vigour of life, and males than females; the inhabitants of temperate climates than those of higher or lower latitudes.

Symptoms of Stone in the Bladder.—These consist in a troublesome itching, sometimes amounting to pain, at the extremity of the penis, with a frequent desire to make water and evacuate the bowels; the urine is voided with great pain, particularly the last drops, and while flowing in a full stream is liable to be suddenly arrested, from the stone falling against the vesical orifice of the urethra. When much irritation is present, the urine on cooling becomes cloudy, and deposits a large quantity of ropy mucus, not unfrequently mixed with blood, especially after any rough exercise. All these symptoms vary in degree, according to the size of the stone and the smoothness or roughness of its surface, its fixed or loose position in the bladder, the quality of the urine, and the condition of the bladder. Instances are recorded of persons living with stone in the bladder for years, yet suffering little or no inconvenience from it; but these cases must be considered exceptions. In general the health sooner or later gives way, and, without recourse to one of the operations we are about to speak of, the patient lingers out a miserable existence till death terminates his sufferings. Nearly all the symptoms we have just described as belonging to stone in the bladder may however be simulated by other diseases of the bladder or neighbouring parts; a positive diagnosis, therefore, can never be made before *sounding* the patient. This consists in introducing into the bladder, through the urethra, a metallic instrument called a sound, by means of which the stone can be plainly felt, and an audible noise perceived on striking it: till this be rendered evident no surgeon would be justified in undertaking the operation. It sometimes happens that stones are forced, by the violent contractions of the bladder during fits of the complaint, between the fasciculi of the muscular coat of this viscus, so as to become what is termed encysted; or they may become adherent to some portion of the parietes of the bladder: under these circumstances the surgeon would hesitate before he undertook the operation.

Modes of performing Lithotomy.—To describe at length the various modes of operating for the stone, and the modifications which each method has undergone, would occupy too much space in a publication not strictly surgical; we shall therefore merely glance cursorily at those formerly in use, while we direct our attention more particularly to the method which is employed at the present day.

Of the Apparatus Minor, Cutting on the Gripe, or Celsus's Method.—This is the most ancient kind of lithotomy, and has probably been practised from time immemorial; but Celsus having first described it, it has been called *Lithotomia Celsiana;* and from the stone, previously fixed by the pressure of the fingers in the anus, being cut directly upon, *cutting on the gripe*, a knife and a hook being the only instruments used. The appellation of the *lesser apparatus* was given to it by

Marianus, in order to distinguish it from a method which he described, called the *apparatus major*, from the many instruments employed. The objections to cutting on the gripe are,—1st, it is only applicable to children under fourteen years of age; 2nd, it is uncertain what parts are divided, this depending on the degree of force employed in making the stone project in the perineum; 3rd, the injury liable to be inflicted on parts whose integrity is essential to the success of the operation.

Apparatus Major, or *Marian Method*, was founded on erroneous principles, and in ignorance of the nature of the parts to be operated on. It was supposed that wounds of membranous parts would not heal, while their dilatation might be undertaken with impunity. In conformity with these notions, the precept of Celsus, "Ut plaga paulo major quam calculus sit," was neglected, and the object endeavoured to be attained was, to do as little as possible with the knife, and as much as possible with instruments called dilators; but the parts thus subjected to attempts at dilatation are inelastic, and consequently were lacerated. The severe injury thus produced rendered this one of the most fatal operations in surgery; but notwithstanding this, it was practised for near 200 years, till Frère Jacques, in 1697, taught at Paris the method at present in use.

High Operation, so named from the incision into the bladder being made above the pubes, was first practised at Paris in 1475, by Colot, as an experiment on a criminal, by permission of Louis XI.; but the earliest published account of this mode of operating was in 1556, by Pierre Franco. This method is most applicable to those cases in which the stone is too large to be extracted from the perineum, or where there is disease of the urethra and prostate gland; but there are several objections to it, and it is now entirely abandoned.

Operation through the Rectum.—This method was first suggested in a work published in the 16th century; but the proposal never received much attention till the year 1816, when it was revived by M. Sanson, of Paris, and carried into operation by him and by Dupuytren; but the unfavourable results which attended the performance of this operation prevented its being generally tried or adopted, and no one of the present day ever thinks of performing it.

Lateral Operation,—so called from the prostate gland and neck of the bladder being cut laterally, in order to avoid wounding the rectum, is that adopted at the present day. It was first practised by Pierre Franco, a surgeon at Tourrières, but he never established the method as a permanent improvement in surgery; this was left for Frère Jacques, a priest, who in 1697 came to Paris in order to make known this method, which he employed with great success at various places. Although it appears that he was not quite so successful as he had led the world to believe, the superiority of his mode of operating was immediately perceived and recognised, and, with slight modifications, was adopted by most of the surgeons of that period. Hitherto the Marian section had been used: the advantages of an operation by which a free opening was made into the bladder, over one in which it was so small as not to admit of the extraction of the stone without laceration of the parts are too obvious to require comment. Surgeons of the present day differ somewhat as to the extent of the opening to be made into the bladder, and on the choice of instruments to be employed: some make use of a common scalpel, which cuts into the bladder from without inwards; while others prefer the bistoire caché, or gorget, which divides the prostate gland and neck of the bladder from within outwards. Having premised thus far, we will proceed to describe the operation as usually undertaken with the cutting gorget. The patient having been sounded, to ascertain that the stone is actually within the bladder (for instances have occurred of stone becoming encysted a short period before the operation), and the rectum being emptied by means of a clyster, he is placed on his back upon a table, with his buttocks projecting rather beyond its edge; he should be directed to grasp the outside of each foot with the hand of the same side, and the two pair should then be firmly bound together. A *staff*, which is an instrument shaped very much like a catheter, or sound, but somewhat longer, and grooved on its convex side, is passed through the urethra into the bladder, where it must be retained firmly by an assistant; its convexity looking towards the perineum, and the groove slightly inclined to the left side of the patient. The operator now commences his incision below the bulb of the urethra, about an inch and a quarter in front of the anus, and continues it obliquely downwards to the left of the raphé of the perineum for three inches, till it reaches midway between the tuberosity of the ischium and the anus: this should cut through the integuments and superficial fascia. The next incision, made in the same direction, divides the transversus perinei muscle, and exposes the membranous portion of the urethra, which must be opened, and the groove in the staff felt for with the finger; into this groove, which serves as a director for making the concluding section of the operation, is inserted the beak of the *gorget* (a sort of knife terminated by a beak, that fits into the groove of the staff). The operator now rises from his chair, and, taking the staff in his left hand, raises its handle from the abdomen till it forms nearly a right angle with the patient's body; the gorget is now pushed onwards, along the groove, till it enters the bladder. By raising the handle of the staff the gorget is made to enter the bladder in a direction corresponding with its axis, and the danger of wounding the rectum is thereby avoided. As soon as the gorget has been introduced the staff is withdrawn, and a pair of long forceps, expressly adapted for this operation, is passed along the gorget into the bladder, and this latter instrument withdrawn. The stone is now to be seized, and gently extracted; but it sometimes happens that a stone is too large to be removed without using a degree of force that would be perfectly unjustifiable: in this case, if the wound will not admit of further enlargement, nothing remains to be done but crushing it, and thus taking it away piecemeal. A stone should always be examined immediately after it is extracted, because its appearance conveys some information concerning the existence of others; and in every instance the cavity of the bladder should be explored with the finger, to ascertain that there is no other stone present. Encysted calculi seldom require an operation for their removal, but should this be necessary, the cyst may be opened by a blunt-pointed bistoury, and the stone taken away. When a stone is known to be of ample size, some operators perform what is called the bilateral operation, from both sides of the prostate gland being cut; for this purpose a double-edged knife has been invented, called the *double lithotome*.

Lithotomy in Women.—From the shortness, largeness, and very dilatable nature of the female urethra, the surgeon is seldom called upon to perform the operation in women. The formation of calculi is perhaps not less common in women than in men; but from the anatomical circumstances just alluded to, stones of considerable magnitude have been voided spontaneously. This fact has suggested the plan of mechanically dilating the urethra, and thus extracting them without the employment of any cutting instruments; but where the stone is very large, the degree of dilatation necessary for its extraction is liable to produce paralysis of the part, and incontinence of urine ever after. To avoid these evils, an artificial opening should be made into the bladder. The operation is simple: a straight staff, or director, is introduced through the meatus urinarius; the groove is turned obliquely downwards and outwards, in a direction parallel to the ramus of the left os pubis; and the knife is thus conducted into the bladder, and makes the necessary incision through the whole extent of the passage and neck of the bladder.

Treatment after the Operation.—The dangers to be guarded against after an operation of lithotomy are, inflammation of the bladder and peritoneum; infiltration of urine into the cellular texture of the perineum and parts adjacent; and hæmorrhage. To prevent the dangers that would arise from inflammation, the patient should be kept perfectly quiet, and on a low regimen; but supposing it to have set in, the most prompt and energetic measures must be had recourse to; venesection, the use of the warm bath and fomentations, with the administration of such medicines as are known to be most efficacious in such cases, afford the only chance of preserving the patient. Infiltration is to be avoided by placing the patient in such a position that the urine can flow readily from the wound, which should be left uncovered, or this end is attained more effectually by introducing an elastic gum catheter into the bladder, and suffering it to remain there for the first two or three days. Hæmorrhage is fortunately a rare occurrence, but should this take place, pressure, made by means of sponge or lint compresses, may be tried; and if this fail, the bleeding vessel must be sought for and tied.

LITHOTRITY (from λίθος, a stone, and the root τρι, to pierce); *Lithotripsy* (from λίθος, and τρίβω, to break), "the reduction of a calculus in the bladder into small pieces, by means of instruments passed into that organ through the urethra, so that the fragments may be discharged through the latter tube, and no necessity remain for the performance of lithotomy." This operation, which must be ranked among the most brilliant achievements of modern surgery, was first seriously proposed in 1812, and Gruithuisen, a Bavarian surgeon, constructed an apparatus for performing it. But the originality of the idea was probably derived from ancient writers, several of whom speak of the practicability of breaking stones within the bladder, although they make no mention of the mode of performing it. At the commencement of the 19th century, Rodriquez, a physician of Malaga, is said to have broken a stone in the bladder by striking it with a catheter; but the first suggestion we meet with of an apparatus constructed expressly for this purpose is by Gruithuisen. It consisted of a wide straight tube, which was introduced through the urethra into the bladder. Through the tube was passed a noose of copper wire (by which the stone was caught hold of and fixed) and a rod terminating in a circle of teeth or a spear-point; a drilling-motion was now given to the latter instrument by means of a bow, and the stone was thus perforated or broken. Since this period, the operation has undergone successive improvements in the hands of Leroy, Civiale, and Heurteloup. The following is the mode of proceeding adopted by this last gentleman. The patient is placed on an operating bed, so constructed as to admit of any inclination being given to it that the operator may think proper. At its foot is an apparatus for affording a fulcrum to the instrument which is to be passed into the bladder; and two slippers, securely fixed at a short distance on each side of the apparatus alluded to, serve for securing the feet of the patient, who is placed in a position nearly resembling that chosen for the operation of lithotomy. The bladder is now moderately distended with warm water injected through a catheter. A pair of strong sliding forceps, the opposite surfaces of which are furnished with teeth, are then introduced; and the calculus having been seized, the lower piece of the forceps is fixed to a vice at the foot of the bed serving as a fulcrum, and the upper piece is struck with a hammer and the calculus broken. Thus, neither the shock arising from the concussion is communicated to the bladder, nor is this organ liable to be injured by the fragments being forcibly projected against its internal surface. The instruments are then withdrawn, and the fragments are afterwards voided with the urine; or if any remain too large to be thus discharged, the operation is repeated from time to time till all is got rid of. It were to be desired that an operation so simple, productive of so little pain, and so entirely free from the dangers attendant on the operation of lithotomy, was more generally applicable than it is found to be, but it is subject to the following disadvantages. The patient does not obtain a cure at once, and in many instances the operation is required to be repeated several times; and as the smallest fragment which remains behind will form the nucleus of a new stone, a recurrence of the disease is more likely to take place after this operation than after lithotomy. It is unfit for calculi formed on extraneous substances which have entered the bladder, for encysted or adherent calculi, for large or very hard calculi, for patients with enlarged prostate gland or diseased bladder, and for children. The accidents liable to arise from the operation are generally less grave than those to which the operation of lithotomy is subject; two of the most serious that have taken place are perforation of the coats of the bladder and the breaking of the instrument within this viscus. But where the stone is small and not too hard, and other favourable circumstances are present, we imagine few could be found who would not give it the preference over the operation of lithotomy.

LITMIC ACID. [LICHENS, COLOURING MATTERS OF.]

LITMUS. [LICHENS, COLOURING MATTERS OF.]

LITMUS, *Medical Uses of.* [ROCHELLA TINCTORIA.]

LITRE, the French standard measure of capacity in the metrical system. It is a cubic decimetre, or a cube whose sides are each 3·9371 English inches. It contains 61·0280 English cubic inches, for four litres and a half make, roughly speaking, an imperial GALLON. The litre is therefore a little less than our quart: more precisely, it is ·22009687 of a gallon.

LITURGY (from the Greek λειτουργία, which originally signified at Athens "certain public functions or duties to which the citizens were personally liable") is a form of public devotion, and more particularly the Office of Common Prayer used in our own church. In the Greek or Constantinopolitan church three Liturgies are in use, those of Basil, Chrysostom, and the Liturgy of the Præsanctified. In the Romish church the Liturgy is divided into several books or offices, as the breviary, the ceremoniale, or office peculiar to the pope; the missal, or office of the mass; the pontificale, directing the functions of the bishops; and the rituale, or pastorale, for the guidance of the simple priests. The Spanish is better known by the name of the Mozarabic Liturgy. The Ambrosian Liturgy is that more particularly in use in the church of Milan. In France the church of St. Martin at Tours had a breviary of its own, which was neither the Roman nor that of Tours; and the same difference obtained at St. Quintin and in other Gallican churches.

At the Reformation all the Protestant churches on the continent, without a single exception, introduced Liturgies for the more uniform celebration of divine service.

Previous to the Reformation of the Church of England the service was performed in Latin, and different Liturgies were used with us, also, in different parts of the kingdom. The cathedrals of York, Lincoln, Hereford, and Bangor, and even Aberdeen in Scotland, had their respective uses; but no cathedral had such a variety of service books for its use as Sarum. "Use" was another name for the Ordinale, or complete service of the church of Salisbury, instituted by bishop Osmund in 1077. It was also named the Consuetudinary; and in Knighton's and Higden's time it obtained almost all over England, Wales, and Ireland. The whole province of Canterbury adopted it, and in right of it the bishop of Salisbury was precentor in the college of bishops whenever the archbishop of Canterbury performed divine service. (Lyndwood, 'Provinc. de feriis' c. ult.)

The publication of king Henry the Eighth's 'Primer' in 1535, in the vernacular tongue, was one of the first steps in the reformation of doctrine and worship in the Church of England. It was followed in 1537 by 'The Godly and Pious Institution of a Christian Man,' containing a declaration of the Lord's Prayer, the Ave Maria, the Creed, the Ten Commandments, the Seven Sacraments, &c., republished with corrections and alterations in 1540 and 1543. In 1545 a second 'Primer' came out; and in 1547, 1st Edward VI., archbishop Cranmer, bishop Ridley, with eleven other bishops and eminent divines, were commissioned by the king in council to compile a Liturgy in the English language free from the erroneous doctrines by which the Latin Liturgies of the church, while unreformed, had been distinguished. This was confirmed by parliament in 1548, and published in 1549. In 1551 it was slightly revised, and again confirmed in parliament; but both this and the former act of 1548 were repealed on the 1st of Mary, as not agreeable to the principles of the Romish Church, which she was about to restore. Upon the accession of Elizabeth the act of repeal was reversed; several learned divines, headed by archbishop Parker, were appointed to make another review of King Edward's Liturgies, when the restoration of the second book of King Edward VI. was determined upon, and finally confirmed by parliament. The Act received the royal assent April 29th, 1559. In the 1st of James I., after the conference at Hampton Court between that prince with Archbishop Whitgift and other bishops and divines on one side, and Dr. Reynolds, with some other puritans on the other, a few slight alterations were introduced, the chief of which consisted in adding some forms of Thanksgiving at the end of the Litany, and an addition to the Catechism concerning the sacraments; and in the rubric in the beginning of the office for private baptism the words "lawful minister" were inserted to prevent midwives or laymen from presuming to baptise. Charles I. made some slight alterations also, by his sole authority. Under the Commonwealth the use of the Liturgy was generally discontinued. Charles II., in 1661, issued a commission to empower twelve bishops and as many Presbyterian divines to consider of the objections raised against the Liturgy, and to make such reasonable and necessary alterations as they should jointly agree upon; nine assistants on each side being added to supply the place of any of the twelve principals who should happen to be absent. On the episcopal side were Dr. Fruen, archbishop of York, Dr. Sheldon, bishop of London, Dr. Cosin, bishop of Durham, Dr. Warner, bishop of Chichester, Dr. Henchman, bishop of Salisbury, Dr. Morley, bishop of Worcester, Dr. Sanderson, bishop of Lincoln, Dr. Laney, bishop of Peterborough, Dr. Walton, bishop of Chester, Dr. Stern, bishop of Carlisle, and Dr. Gauden, bishop of Exeter. On the Presbyterian side were Dr. Reynolds, bishop of Norwich, Dr. Tuckney, Dr. Conant, Dr. Spurstow, Dr. Wallis, Dr. Manton, Mr. Calamy, Mr. Baxter, Mr. Jackson, Mr. Case, Mr. Clark, Mr. Newcomen. The coadjutors on the Episcopal side were Dr. Earles, dean of Westminster, Dr. Heylin, Dr. Hackett, Dr. Barwick, Dr. Gunning, Dr. Pearson, Dr. Pierce, Dr. Sparrow, and Mr. Thorndike. Those on the Presbyterian side, Dr. Horton, Dr. Jacomb, Mr. Bates, Mr. Rawlinson, Mr. Cooper, Dr. Lightfoot, Dr. Colins, Dr. Woodbridge, Mr. Drake. These commissioners held several meetings at the Savoy, but to little purpose. The king's commission gave them no further power than to "compare the Common-Prayer Book with the most ancient Liturgies that had been used in the church in the most primitive and purest times;" and required them "to avoid as much as possible all unnecessary alterations of the forms and Liturgy wherewith the people were altogether acquainted, and had so long received in the Church of England." The Presbyterians, however, would not allow that the Liturgy was capable of amendment, and Baxter had prepared and offered one of his own to be substituted in its room. The Conference at length broke up without anything being done, except that some particular alterations were proposed by the Episcopal divines, which in the May following were considered and agreed to by the whole clergy in convocation. The principal of them were, that several lessons in the Calendar were changed for others more proper for the days; the prayers for particular occasions were disjoined from the Liturgy, and the two prayers to be used in the Ember-week, the prayer for the parliament, that for all conditions of men, and the general Thanksgiving were added; several of the Collects were altered; the Epistles and Gospels were taken out of the last translation of the Bible, being read before according to the old translation; but the older version of the Psalms was retained; the office for baptism of those of riper years, and the Forms of Prayer to be used at sea, were added. In a word, the whole Liturgy was then brought to that state in which it now stands; and was unanimously subscribed by both houses of convocation of both provinces on Friday, 20th of December, 1661; and being brought to the House of Lords the March following, both Houses passed an Act for its establishment; the Earl of Clarendon, then lord chancellor, was ordered to return the thanks of the lords to the bishops and clergy of both provinces for the great care and industry shown in the review of it; and it received the king's assent on May 19, 1662.

Among what are called the Additional Manuscripts in the British Museum is 'An Apparatus of Materials,' in forty-five volumes, being a collection of notes and observations on the Liturgy, and various other subjects connected with the offices of the church, by a clergyman of the Church of England, who directed them to be deposited in that institution, but that his name should remain unknown. These volumes were deposited in the British Museum in 1791.

Within the last few years several attempts have been made, but hitherto successfully opposed by the heads of the church, to obtain a revision of the Liturgy, the objections stated to it being that it is too long, and has too many repetitions, for one service, to which others add that particular parts require alteration or modification.

LI'TUUS, a name given to a spiral thus described:—Let a variable circular sector always have its centre at one fixed point, and one of its terminal radii in a given direction. Let the area of the sector always remain the same; then the extremity of the other terminal radius describes the lituus. The polar equation of this spiral is $r^2\theta = a$.

LI'TUUS, a crooked staff resembling a crozier, used by the augurs among the ancient Romans in making their observations on the heavens, hence called the *Augural lituus*. Dr. E. D. Clarke asserts that there was an older lituus, called the *Regal* or *Quirinal lituus*, which the ancient kings of Italy held as a sceptre in their hands long before the time of Romulus or the institution of the Augurate, particularly mentioned by Donatus and Servius in their Commentaries upon Virgil.

The lituus is often represented on Etruscan and Roman works of art. A sort of horn or trumpet, the end of which was curved, and which emitted a sharp shrill sound, was also called a lituus. It was used for sacerdotal purposes, and in the army. The etymology of the name is uncertain; but it is believed that the word was borrowed from the Etruscans, as there is little doubt that the augur's lituus itself was.

LIVE STOCK. The animals necessary for the stocking and cultivation of a farm, and those which are kept on it for profit, or for the sake of their dung, are called the live stock of the farm, in contradistinction to the dead stock, which consists of the implements of husbandry and the produce stored up for use.

The live stock on a farm must vary according to circumstances. The number of horses or oxen kept for the cultivation of the land and other farming operations should be exactly proportioned to the work to be done. If they are too few, none of the operations will be performed in their proper time, and the crops will suffer in consequence. If there are too many, the surplus beyond what is strictly required is maintained out of the profits of the farm. To have the exact number of animals which will give the greatest profit is one of the most important problems which a farmer has to solve: what may be very profitable in one case may be the reverse in another; and, as a general maxim, it may be laid down, that the fewer mouths he has to feed, unless they produce an evident profit, the less loss he is likely to incur. But this rule admits of many exceptions. It is of great importance, in taking a farm, to calculate the extent of the arable land, so that it can be properly cultivated by a certain number of pairs of horses. It is an old measure of land to divide it into so many ploughs, that is, so many portions which can be tilled with one plough each. When there are several of these, it is useful to have an odd horse over the usual number required for two or three ploughs, to relieve the others occasionally. The work is thus done more regularly and with greater ease. Where there are two ploughs with two horses each, a fifth horse should be kept, and so in proportion for a greater number. The odd horse will always be found extremely useful, if not indispensable, and the expense of his keep will be amply repaid by the regularity and ease with which the whole work of the farm will be done, and the relief which occasional rest will give to the other horses.

The other part of the live stock kept on a farm must depend on various circumstances. Where there is good grazing land, the profit on the improvement of the live stock, or their produce, is evident and easily ascertained. But where animals are kept upon artificial food or fatted in stalls, it is often a difficult question to answer, whether there is a profit on their keep or not. In most cases, the manure which their dung and litter afford being considered, there is no loss. If manure could be obtained in sufficient quantities to recruit the land, at a reasonable price, it might often be more advantageous to sell off all the hay and straw of a farm, and to keep only the cattle necessary to till the ground or supply the farmer's family. But this can only be the case in the immediate neighbourhood of large towns. In the country at a greater distance, manure must be produced on the farm; and for this purpose live stock must be kept. The management and feeding of live stock is therefore an important part of husbandry, and more skill has been displayed in the selection of profitable stock than in the improvement of tillage. Some men have made great profits by improving the breed of cattle and sheep, by selecting the animals which will fatten most readily, and by feeding them economically. It requires much experience to ascertain what stock is most profitable on different kinds of land and in various situations. Unless very minute accounts be kept, the result can never be exactly known. It is not always the beast which brings most money in the market that has been most profitable; and many an animal which has been praised and admired has caused a heavy loss to the feeder. Unless a man breeds the animals which are to be fatted, he must frequently buy and sell; and an accurate knowledge of the qualities of live stock and their value, both lean and fat, is indispensable. However honest may be the salesman he may employ, he cannot expect him to feel the same interest in a purchase or sale, for which he is paid his commission, as the person whose profit or loss depends on a judicious selection and a good bargain. Every farmer therefore should endeavour to acquire a thorough knowledge of stock, and carefully attend all markets within his reach to watch the fluctuation in the prices. It will generally be found that the principal profit in feeding stock is the manure, and to this the greatest attention should be directed. A little management will often greatly increase both the quantity and quality of this indispensable substance, and make all the difference between a loss and a profit in the keeping of stock. [MANURE.]

LIVER, DISEASES OF THE. The liver is subject to all those general morbid changes which, depending on disordered actions of the blood-vessels, modification of the nutritive process, or alterations in the blood itself, may affect most organised parts of the body; such are inflammation (hepatitis), acute and chronic; hypertrophy and atrophy; induration and softening; and the different kind of tumours or transformations of tissue, carcinoma, or cancer, medullary sarcoma, fungus hæmatodes, melanosis, and scrofulous tubercle. It is occasionally infested by parasitic animals (hydatids), which may likewise affect other parts of the body.

But the liver is also liable to other diseases which appertain to it specially, and are connected with its function—secretion. The chemical changes which give rise to the formation of bile in the liver may be so deranged, that one or all of the ingredients of that fluid are increased or diminished in quantity, or vitiated in quality, and such disorder of the secreting process may manifest itself in several ways: the imperfectly formed fluid passing into the intestines may cause irritation there, and consequently diarrhœa: or being absorbed into the blood, may produce jaundice and its concomitant symptoms; or some of the ingredients of the bile may concrete into solid masses in the ducts of the liver or the gall-bladder, forming gallstones. The diseased state of the liver in which it becomes impregnated with an unnatural quantity of fatty matter may also be reckoned among the diseases appertaining to the special function of the organ, for the bile naturally contains a large proportion of fatty matter (cholesterine); though the chemical composition of this substance, and that of the oil or fat with which the liver is impregnated in disease, appear to be different. [LIVER, in NAT. HIST. DIV.]

Congestion of the Liver.—The complicated structure of the liver renders it possible for various parts of its tissues to become congested. Thus there may be congestion from an increased secretion of bile, and in this case the bile ducts are the parts principally affected. Then the hepatic veins, or the portal veins, may be congested, and this is called *passive congestion;* whilst *active congestion* is said to be present when the arterial capillaries are principally affected. Each of these forms of congestion is attended with peculiar morbid appearances, which have been discovered after death. In these congestions the liver is generally enlarged. In certain states of congestion of the liver, the condition known by the name of *nutmeg liver* is present.

The most frequent cause of hepatic congestion is disease of the heart. When obstruction exists to the circulation, especially on the right side of the heart, the liver is liable to congestion. Such a state is attended with dropsical effusion of the abdomen, and also of the general cellular tissue. Temporary congestion of the liver may be also brought about by sudden chills, the cold stages of fevers, the drinking too largely of alcoholic liquors, injudicious feeding, and exposure to the heat of the sun. In congestion the liver is enlarged externally, there is sallowness of the complexion, the tongue is coated, the bowels constipated, the appetite bad, and there are sickness, vomiting, headache, and general debility. The pulse is slow, compressible, or irregular, or it may be quiet and feeble.

The treatment of congestion of the liver needs not to be very active. Gentle purgatives and diuretics, with rest, and a restricted diet, are generally sufficient.

Acute hepatitis, when it exists in a severe degree, is indicated pretty distinctly not only by the general signs of inflammation and symptomatic fever, such as thirst, heat, and dryness of the skin, increased rapidity of the pulse, &c., but also by local symptoms, which point more especially to the seat of the disease, namely, pain and tenderness on pressure beneath the ribs on the right side, difficult breathing from the liver being pressed upon by the diaphragm when air is drawn into the lungs, and a short dry cough, dependent either on the extension of the inflammation to the diaphragm, or a sympathetic affection of the parts engaged in respiration. The pain in hepatitis so frequently extends to the right shoulder, that pain in that situation has been considered characteristic of disease of the liver. Vomiting is a common attendant on hepatitis, as on inflammation of most of the abdominal viscera. Another symptom is jaundice, which in this case is a consequence of the inflammatory action having disturbed the process by which the components of the bile are formed and separated from the blood.

Inflammation of the liver may terminate in suppuration, and the formation of one or more abscesses, which sometimes attain a very large size in this organ, protrude externally, and even burst and discharge their contents through an opening in the skin.

Acute inflammation may be produced in the liver by any of the influences which give rise to it in other organs; but while the lungs are more subject to this affection in cold climates, the liver is especially liable to it in hot countries.

Chronic hepatitis is indicated by the presence, in a less violent degree, of many of the symptoms which attend the acute disease. Thus, a dull pain or sense of weight in the right side, with some degree of tenderness in the same situation, pain in the right shoulder, slight jaundice or sallowness of the skin, and disorder of the stomach and digestive organs generally, are the most constant signs. It is frequently difficult to distinguish mere chronic inflammation of the liver without enlargement from some disordered states of the stomach and bowels, which sympathise so much with it, and hence has arisen the popular error of designating any chronic disorder of the digestive organs "a liver complaint." We cannot be surprised at this sympathy between the liver, stomach, and bowels, and other viscera of the abdomen in disease, since we know that they are all engaged in one great function —digestion; and are in the healthy state associated together in their action by a natural sympathy for the purpose of co-operation in that function. A structural result of the chronic inflammation of the liver is the deposit of fibrinous matter in its capsular structure, and the production of the diseased state called *cirrhosis.* This is frequently brought on by the abuse of alcoholic beverages, and has got the name of "gin liver."

Increased secretion of bile. The function of the liver is increased by exposure to heat, and there is evidently a relation between the function performed by the lungs and that of the liver. As the former is diminished, the latter is increased. This occurs from exposure to heat, and is especially seen in the case of Europeans exposed to the heat of tropical climates, or in the hot weather of temperate climates. An increased secretion of bile is attended with an increased action of the bowels, called "bilious diarrhœa." Such increased secretion of bile is attended with congestion, which may terminate in inflammation of the liver, which is attended with a diminution of the biliary secretion.

Various causes may produce a suspension of the processes by which the bile is thrown out of the liver. When this occurs, the bile is absent from the intestinal excretions, and being taken up into the blood produces jaundice. [JAUNDICE.]

The liver is very apt to become enlarged by chronic inflammation, and then can be felt externally. Or such changes may be produced in it by hypertrophy or atrophy of one or more of the tissues composing it, or by the formation of a new tissue, that the passage of the blood through it is impeded, and dropsy of the abdomen (ascites) is the result; this effect however is sometimes a consequence of the chronic inflammation of the liver having extended to the whole lining membrane of the abdominal cavity.

Of the structural diseases, not inflammatory in their nature, some, as scrofulous tubercles, are rarely met with in the liver, others, as carcinoma, are more frequent in it than in most other internal organs, except the intestinal canal. There are no certain means of ascertaining the presence of these diseases in the liver, until the tumours which they form attain such a size as to be felt externally; though it should be suspected, when the general states of the body marking the carcinomatous and tubercular diathesis exist, and still more when these diseases are known to be present in other parts, if at the same time there are marks of irritation and disturbed action of the liver.

The "fatty liver" is a frequent attendant on pulmonary phthisis: it cannot be recognised by any signs during life.

The liver in man, as in many animals, particularly the sheep, is, as we have said, subject to become the seat of parasitic living creatures—hydatids. These are generally contained in great numbers in a firm general cyst, which not uncommonly protrudes externally, and bursts, or is opened by a lancet, when numerous pellucid bladder-like bodies of different sizes, floating in a transparent fluid, escape.

The *treatment* of diseases of the liver is regulated by the general principles according to which the cure of diseases in other parts is attempted, and will of course vary with the nature of the particular affection requiring it.

LIVER OF ANTIMONY. [ANTIMONY.]

LIVER OF SULPHUR. [POTASSIUM, *Sulphides of.*]

LIVRE, anciently a money of account in France, afterwards a coin. The word is derived from the Roman *libra*, or pound, the standard by which the French money was regulated, twenty sous being made equal to the livre, or libra. Under the decimal system, accounts are now kept in francs of 20 sous, of 10 decimes each, and each decime is divisible into 10 centimes.

The livre was formerly of two kinds, Tournois and Parisis. The *Livre Tournois* contained 20 sous Tournois, and each sol or sous 12 deniers Tournois. The *Livre Parisis* was of 20 sous Parisis, each sous worth 12 deniers Parisis, or 15 deniers Tournois; so that a livre Parisis was equivalent to 25 sous Tournois; the word Parisis being used in opposition to Tournois on account of the rate of money, which was one-fourth higher at Paris than at Tours.

The *Lira Italiana* is the Italian livre, and it varies in value in several states. In Austrian-Lombardy and Piedmont it was worth 8*d.*; in Tuscany 7½*d.*; but the currency has been latterly approximating to the French system, which is now likely to become general.

LIXIVATION, a term employed chiefly in *technical* chemistry to denote the dissolving out of saline matters from an insoluble residue: thus *black ash* is lixivated with water to dissolve out its constituent carbonate of soda, from other insoluble matters consisting chiefly of oxysulphuret of calcium. The solution thus obtained is termed a *lixivium.*

LIXIVIUM. [LIXIVATION.]

LIZARIC ACID. [MADDER, COLOURING MATTERS OF; *Alizarin.*]

LOADSTONE. [MAGNET.]

LOAM, a soil compounded of various earths, of which the chief are silicious sand, clay, and carbonate of lime, or chalk. The other substances which are found in loams, such as iron, magnesia, and various salts, are seldom in such proportions as materially to alter their nature. Decayed vegetable and animal matter, in the form of humus, is found in loams in considerable quantities, and the soil is fertile in proportion.

According as the loams are composed, so they vary in quality. Those which consist of a great portion of loose sand, with little vegetable matter, and with an impregnation of iron, are very unproductive; and those which contain too much clay, and are on an impervious subsoil, are very difficult to cultivate. But between these extremes there are soils which cannot be surpassed in fertility as wheat-land. What renders loams so much more fertile than either clays or sands is, that the pure earths are in themselves almost entirely barren: sand lets the moisture run through it and evaporate rapidly; clay retains it, but locks it up in its own substance, and does not allow the tender young roots of plants to push through it; chalk has the same mechanical quality, besides containing very little organic and soluble matter, from which plants derive their chief increase. Sand and clay alone, without a considerable portion of organic matter, will not make a rich soil; but when a portion of calcareous earth is joined to both, the vegetable matter is more readily rendered soluble, and the clay and sand are prevented from forming a mortar, which would harden too readily, and prevent the influence of the air from reaching the roots. Good loams allow of that circulation of moisture which acts so prominent a part in the process of vegetation. It is almost universally admitted that the most fertile soils always contain a proportion of calcareous matter; and by adding chalk to those soils in which it does not abound, whether sandy or argillaceous, a manifest improvement is always produced.

It has been asserted that in the climate of France, in the neighbourhood of Paris, the best soil for the growth of wheat is composed of equal portions of fine sand, clay, and chalk. Upon what grounds this is assumed, does not appear very clear. The greater the natural moisture of any climate, the greater proportion of sand is required to make a fertile loam; and the greater the proportion of humus, the less sand will be required to temper the clay. The analysis of soils known to be extremely fertile gives a very great difference in the proportions of the different earths.

In the climate of England the soil which is generally preferred for cultivation is a loam, rather light than heavy; at least half of which is silicious sand, one-third clay, and the rest chalk. Such a soil is called a good loam; it is land which will produce almost every thing which is usually cultivated on sands or clays: it is not too stiff for carrots and turnips, and not too loose for wheat and beans. It is of most easy cultivation at all times of the year, provided the subsoil be sound, and not too retentive of water. It requires only to be occasionally recruited with manure, to restore to it what vegetation has consumed, and to be kept free from the weeds which naturally spring up in all fertile soils. All attempts to improve the nature of a soil should have for their object the bringing it to a state of loam, by the addition of those substances which are deficient. If there is too much clay, chalk and sand may be added, or a portion of the clay may be calcined by burning, in order to destroy its attraction for water, and thus act the part of sand in forming the loam. Limestone or calcareous sand and gravel are still more efficacious for this purpose: they not only correct too great porosity, or too great tenacity, but also act chemically on the organic matter in the soil, rendering it soluble, and fit to be taken up by the roots of plants. If there is too much sand, marl composed of clay and chalk is the remedy. Good loams require much less tillage than stiffer soils, and will bear more stirring to clean them than sands. Hence they are cultivated more economically, and more easily kept free from useless weeds; while the produce is more certain and abundant. They can be impregnated to a higher degree with enriching manures, without danger of root-fallen crops, or of too great an abundance of straw at the expense of the grain. For artificial meadows they are eminently proper: all the grasses grow well in good loams, when they are on a dry or well-drained subsoil, which is an indispensable condition in all good land. Sheep and cattle can be depastured on them during the whole year, except when there is snow on the ground. If there should be means of irrigation, no soil is better suited to it than a light loam on a bed of gravel; or even if the subsoil is clay, provided sufficient under-draining prevent the water from stagnating between the soil and subsoil, which, as practical men very properly express it, would poison any land.

A loamy soil requires less manure to keep it in heart than either clay or sand; for while it is favourable to the process by which organic matter buried deep in the soil is converted into insoluble humus, it also permits that part of it which is nearer to the surface to attract oxygen from the air, and thus it is converted into a soluble extract, which is to the roots of plants what the milk of animals is to their young—a ready-prepared food easily converted into vegetable juices.

The analysis and classification of soils is of the greatest importance to all those who take farms; for the rent of land is very seldom proportioned to its intrinsic value: one farm may be worth double the rent of another, where the apparent difference in the soil is very trifling. Those who have had long experience of the expense of cultivation, and the average produce of certain lands, can nearly guess what rent it may be safe to offer; but a stranger has no criterion to judge by. Hence it is notorious that a stranger coming to take a farm from a distant district is almost invariably deceived. Why should not the value of a soil be ascertained as readily as that of any article of commerce? If there were certain points of comparison, it would be so; but in this the theory of agriculture is woefully deficient. A man guesses at the qualities of land by the colour, the feeling, and other uncertain signs: it seldom or never occurs to a farmer to examine the component parts of a soil, by merely diffusing a portion in water, and testing the deposits—much less to compound artificial soils, and compare them with those found in the fields. Yet every gardener can prepare soils suited to different plants, and make loams of all degrees of richness or consistence. In all these it will be found that sand, clay, chalk, and decayed vegetable substances, in various proportions, are the chief ingredients. If therefore these are found in a natural loam, we may safely conclude that it would be equally productive, and the deficiency of one ingredient may be supplied artificially. This would be going rationally and scientifically to work; and the result would be a more certain and satisfactory practice of husbandry.

LOBELIA INFLATA (Bladder-podded lobelia, or Indian tobacco), *Medical properties of.* This American annual plant possesses in its whole structure some very peculiar properties, approximating to Virginian tobacco so closely as to have received a nearly similar name. The plant flowers in July, and the entire plant or herb is to be taken up in August or September; every part possessing the characteristic properties. These display themselves quickly on those unaccustomed to the use of this herb, even when only a small portion is held in the mouth. "It produces giddiness and pain in the head, with a trembling agitation of the whole body; and at length brings on extreme nausea and vomiting. The taste resembles that of tartar emetic." (Bigelow's 'Medical Botany,' an American Work.) Its secondary effects are great flow of saliva and increased expectoration, with general relaxation of the muscular system, and depression of the heart's action. Small doses are useful in asthma, but in hooping-cough greater relief may be more safely procured by enveloping the chest with flannels steeped in a tepid decoction of poppy heads; renewing these frequently. The seeds are very small, beautifully reticulated, so that they can be easily recognised under the microscope. In cases of an overdose, strong tea, then brandy and ammonia, should be given.

LOBELINE, an oily non-volatile alkaloid found in the Lobelia (*Lobelia inflata*). It is very soluble in water, alcohol, and ether. Administered to animals, it produces narcotic effects.

LOCAL ATTRACTION, a term accepted by men of science as applicable to influences exerted on the compass by substances on shipboard. Few subjects have taxed the patience and intelligence of nautical men so much as that of the disturbance of the compass by local attraction; nor has the consideration of the subject by living philosophers been productive of more than a verification of certain suspected facts.

Professor Airy has indeed deeply investigated the causes as they ordinarily appear, and has been successful in providing some alleviation of the evils attendant upon a disturbed compass; but in other respects nothing of permanent benefit has accrued to the compass question either from committees, or from elaborate experiment; nothing which aids the seaman by an infallible remedy. Were a ship to remain always in nearly the same part of the globe, and her local attraction to remain a constant quantity, Airy's improvements would be all that could be desired; as it is, no other mechanical means of correcting by magnets in a long voyage is so convenient or so manageable.

That the compass was subject to changes and deflections irrespective of terrestrial magnetism, was of little importance in ships constructed only of wood. Irregularities of the compass were occasionally detected, but these were mostly attributable to iron bolts or nails, or accidental deposits of metal, such as a knife or marlinspike upon or near the binnacle. Beyond these casual or accidental disturbances, the mariner of olden time had little to do with local attraction. An iron cargo occasionally caused him some extra watchfulness, but the error once ascertained left him at ease upon the subject of his compass. No sooner however had the interest of merchants increased the space for stowage in their ships, and, in adopting modern improvements, introduced iron knees, chain rigging, and various other metallic appliances, than the consideration of the actual compass course to be steered became involved in new and perplexing corrections, and various speculations concerning a ship's condition as altered by these improvements became the subject of study. For nearly a quarter of a century this state of things was suffered to progress, when the establishment of the present Board of Trade, and the intelligence of its naval heads, introduced a new and still enduring scrutiny.

Ships had begun to be constructed of iron only; some had been built many years previously—for the writer remembers seeing the first iron vessel which ever anchored in the Downs, a fine brig called the 'Tontine,' in about the year 1816. From iron hulls, iron masts and even yards, soon were to be found afloat in British waters. And as if the compass were to be threatened with total rejection, iron ships were soon fitted with steam engines. Wooden steamers had already (about thirty years since) exercised the patience and vigilance of ship masters to a large extent, but changes so enormous were gradually producing a malignant phantom more and more forbidding in its aspect, from its power of eluding the grasp of its pursuers, and deluding them into still deeper swamps of error and disappointment. Such effects then had at first "local attraction." Some, to avert the evils of an invisible and fickle agency, fastened magnets to their decks as palliatives, but they did so with as many misgivings as they still fasten the horseshoe to the bowsprit end. Any species of "charm" which the credulity of the superstitious could invoke to avert mischief from the compass was eagerly applied to its bowl, or the binnacle, or to the deck, until in 1854, the unfortunate catastrophe of the 'Tayleur,' a fine ship of above 3000 tons (actual measurement) built of iron throughout, and having compartments also of iron, was lost with 290 of her crew at Lambay, on the Irish coast.

The investigation of the causes of her loss resulted in an official report from Captain Walker, (one of the naval heads of the Board of Trade) attributing her destruction to the "supposition" on the part of the Captain, "that the compass before the helmsman was correct," and alleging that the captain "was aware there was a difference of two points between the compasses, but he knew not which was in error."

We see then the effects of compass disturbance, and proceed to examine the causes, but have to deal with the circumstance of local attraction being liable to sudden and great changes, so that corrections which are available and effective at one period are totally useless at another. It is this change which baffles us, and in it lies the greatest amount of danger to navigation.

Dr. Scoresby, in his patient experiments and indefatigable attention to the subject through many years, has shown that some portion of a ship's local attraction may be traced to her very cradle—that the very hammering and rolling, and bending, and riveting of her plates engenders a mischievous influence variable in its intensity as in its duration, and is thus coexistent with the origin of her frame-work itself. That even the direction of the line of keel while building, as measured by its angle with the magnetic meridian, establishes for a time a systematic derangement of the action of terrestrial forces in which the effects of terrestrial dip and obliquity have their united influence, which may or may not affect the future navigation of the ship by means of a mariner's compass.

Were the efforts of Dr. Scoresby, and Mr. J. R. Napier (the eminent iron ship-builder of Glasgow), and the approach to principles developed by them, not countervailed by the changes incident to every iron ship on leaving her birth-place, little would remain to the sea captain but to receive from the hands of the builder, a diagram of the ship's magnetic condition, as produced by the causes already referred to; and indeed as palpably evident and accurate as her load and light water lines, &c., would be the correcting card so handed over; for it is not difficult to discover a neutral point in every iron ship, at which a standard compass would feel the effects of terrestrial magnetism only. But no sooner, unfortunately, in the process of launching does the ship, if built of metal, plunge into a denser medium, such as water, than the sudden change of temperature affecting the submerged portions of the mass, communicating itself to the upper works, challenges at once the stability of her magnetic condition. Nor is this, at this period, the only enemy to magnetic permanency, for it has been shown by Dr. Scoresby, that the very twist and strain in the framework of the ship consequent upon her being, in launching, raised gradually by the buoyancy of the water, is sufficient to affect materially that which other influences had matured.

The iron ship being once afloat, we shall find still other perplexing disturbances at work, and especially if she be intended for a steamer, with iron masts and yards.

If the latter, the increased hammering in the fitting of the engines adds its quota to the general confusion of conflicting and counteracting forces. The lighting of the fires, the heating of the boilers, the production of steam—each of these is a fertile source of further electric, and therefore magnetic, disturbance. It would seem that the consideration of thermo-electricity, as operating upon the mass of metal in an iron ship, has been somewhat neglected. The enormous change of a single drop of water, which, on its conversion into steam, is expanded into 1700 times its bulk, has been proved years since to generate, or rather to release, a vast amount of electric or magnetic power; and as we cannot circulate electric currents without magnetising iron, when in certain favourable positions with regard to it, the complication of disturbances is so great in an iron steamer that it is not surprising if the wisest heads fail in providing a permanent remedy for local attraction. Ships are "swung" generally at this period, and the question of compass error is supposed by many to have been satisfied if the amount of then existing deviation is recorded. But what follows?

If we test an iron pillar or bar of even a tradesman's shop-front, we shall find that in time, and from its vertical position, it becomes magnetic, and exhibits polarity: and this law affects every vertical bar in the ship. It is an error to suppose that the weight of an iron mass has reference to its magnetic intensity; for, as magnetism seems to collect on surfaces of metal, it follows that a 6-inch hollow iron pipe or funnel, having two surfaces, an inner and an outer, would exhibit more power of disturbing a compass than if it were of solid iron: therefore stove-pipes have been often found dangerous neighbours to a standard or binnacle compass—much more so should we expect an iron mast to be. Hence the very parts used in the construction and fitting of an iron ship are liable to the change to which we have adverted, and this change may be either an increase or diminution of magnetic influence, we know not which; as one piece of iron used in the construction of the ship may and does counteract another, partially or wholly; the change moreover may be either rapid or protracted, until some other new source of disturbance comes into controlling operation.

In process of preparation for sea, cargo of various materials, such as hardware, machinery, or iron bars themselves, loads the ship, increasing the *strain* upon her plates and knees, &c. With regard to iron bars as a cargo, let any one walk round a heap of bars lying upon a wharf, with a pocket-compass, and remark their effect on the needle (whether lying *out* of or *in* the magnetic meridian should be noted). It must be remembered that these are to be placed, we will suppose, in an already magnetised iron ship, and subject, especially in an iron steamer, to another serious source of change, a change in temperature. Now it is known from experiment that the intensity of a magnet is nearly doubled by being raised to a "cherry-heat:" the change of temperature in a ship's hold may, even in the tropics, be considered comparatively insignificant, but the fact remains that disturbance of temperature is disturbance of electricity, and as no electric current can circulate without its attendant magnetism acting at right angles to the direction of such current, it follows that totally unexpected and most intricate and untraceable influences may be set in operation, even by lighting the furnace fires for a few hours in order to take still further precautions in the usual "trial trip" to test both engines and compass. This is another stage at which it is deemed by the majority prudent to finally adjust the "correcting card" for the voyage. This is especially the period of "swinging" her majesty's ships, with what certainty of permanent advantage may be still further illustrated.

We have mentioned her majesty's ships—as an extreme case we now will confine our deductions to the incidents attending their proceeding to sea. It is fair to assume that ships are fitted in still waters, either in harbours or estuaries; whether such ships be new, or have been lying dismantled in ordinary, affects our main scrutiny as to changes in a very immaterial degree. In either case, whatever changes do occur they are due to what Scoresby has called retentive magnetism. Now guns are formed of a metal which, from partial carbonisation, rapid or unequal cooling, and a tendency to crystallisation, or at least a peculiar arrangement of its particles, has in the ordinary form of cast-iron a peculiar aptitude for the absorption of magnetic influence: and, indeed, excellent permanent magnets may be formed of it, inferior only to steel. These guns have moreover to undergo a process of concussion in firing still further calculated to derange local attraction, by increase or diminution, we cannot tell which: and even the training of these guns may, in their altered position, affect the local attraction of the whole ship.

And again, independent of the evolution of magnetism in the boiler, the very act of combustion of coal has its influence on the condition of an iron steamer. For not only does the combination of carbon with the oxygen of the air (which is decomposed in the furnace in the act of combustion) in the form of carbonic acid gas increase the magnetic intensity of the funnel, but the decomposition of the coal itself is a source from which magnetism is as it were *poured into* the very mass of the ship herself in abundance, perhaps to saturation, if such can exist. In addition to the electro-magnetic disturbance incidental to all decompositions, coal is composed of carbon and "earthy matter." Now pure carbon is of itself capable of polarity, inasmuch as crystallisation is found in the diamond: but the "earthy matter" is worthy of serious examination. Coal varies greatly in the quantity of earthy matter it contains, and for the following reasons: the lower the specific gravity of the coal used, so much the less probability of magnetic disturbance one might look for.

Earthy matter in coal amounts to, in general, from 1 to 10 or 12 per cent., such being either pure oxide of iron, or sulphuret of iron with occasional traces of alumina. Now if we, for experiment, burn off the sulphur by the blowpipe from a small portion of sulphuret of iron, or iron pyrites, we shall find the residue strongly magnetic; and this may be verified by our taking some of the dust of the ash-pit of a furnace, or of a common house-grate, and placing it on a piece of writing-paper; holding a magnet under the paper will at once show polarity in the particles, and moving the magnet along the surface and back again will abundantly show that combustion of coal therefore produces constantly a large number of small distinct magnets, the power of which is increased not only by their being in proximity to each other, but by the high temperature at which they are maintained until usually removed from the ash-pit. When we further consider that in a large steamer some 100 to 200 tons of coal are consumed in a day, it is not too much to say that some tons of magnets are manufactured daily on board these vessels: we say manufactured, for in the form of coal, or even as sulphuret of iron, such is not magnetic.

And again, with all these tendencies to produce a disturbing effect on the known or once ascertained local attraction of the ship, there remains yet the possibility of further inconvenience to the compass arising from heavy pitching or rolling in a sea way: even her "heeling over" is well known to affect the compass to a considerable degree.

Such then is "local attraction" on shipboard; an influence from which no ship nearing the land would be safe, as the changes referred to cannot be anticipated or averted by any process yet known. It remains, therefore, to renew "corrections" as often as possible, using a heavenly body as the sole standard. Under the article COMPASS CORRECTIONS it has already been shown how readily and completely this may be done by means of Saxby's spherograph and Professor Airy's arrangement of soft iron and magnets. Local attraction on shipboard is, therefore, a subject for anxious vigilance on the part of every commander. Many ships are found very unsusceptible of changes; others, after years of inactivity, suddenly become excited. As a general rule, local attraction is expected to diminish after a ship has been a year or two at sea: but no ship or vessel, especially a steamer, ought to be navigated by means of a correcting card, unchecked by frequent celestial observations, for at least the first week or two after leaving port. A prudent commander will never trust to his compass for a single day if azimuths can be taken.

(*Nautical Magazine;* Dr. Scoresby, *Magnetical Investigations;* &c.)

LOCI. [LOCUS.]

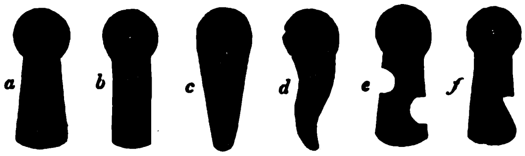
LOCK, a fastening in which a moveable *bolt* may be projected by the action of a *key*, introduced into the lock in such a manner that the bolt cannot be returned to its original position, so as to release the door or cover, excepting by another application of the key. There are, however, many locks in which the bolt is projected by the action of a spring, without the aid of the key, and in which it may be drawn back by means of a handle; although it cannot be moved from the other side without the application of the key. In other locks, again, there are two or more bolts, one of which only is under the control of the key, the others being moved by handles; while in another class two or more bolts are shot or projected by the action of the key alone. In addition to such differences, the varieties in the form and size of locks, and in the arrangement of their parts, are almost infinite. In door and closet locks, the bolt is usually projected into a fixed socket. In various kinds of box and cabinet locks the bolt is not projected beyond the casing of the lock, but is caused to shoot into or through a staple which drops into the lock to receive it. In desk-locks and some others the bolts project permanently, and are of a hooked shape, adapted to catch, by a lateral movement, into staples provided to receive them. *Padlocks* are a kind of detached lock in which a curved bar of iron, pivoted to the lock at one end, may be passed through a staple, and then so secured by shooting the bolt into a cavity in its free end, that it cannot be removed from the staples through which it has been passed.

By far the greater number of the contrivances for rendering locks inviolable may be classed under one of three systems of security.

Warded Locks.—The key of an ordinary lock consists of a cylindrical shank with a loop-shaped handle at one end, and a piece called the *bit* projecting from it at or near the other. The bit end of the shank is, in the keys of locks which are to be entered by the key from one side only, made hollow or tubular, to fit on to a pin fixed in the lock; but in locks which may have to be opened from either side, such as ordinary room-door locks, the shank is made solid, and is prolonged beyond the bit, so as to enter the upper part of the key-hole of that plate of the lock which happens to be farthest from the person applying the key. The projecting bit, after being introduced through the key-hole, is turned round within the lock by a rotatory motion imparted, until it comes in contact with a part of the bolt so shaped that the bit cannot pass it, to complete its revolution, without shooting the bolt either backwards or forwards, as the case may be. When thus moved the bolt is retained in its position by a spring, or some other means, until it is again moved by the reverse action of the key.

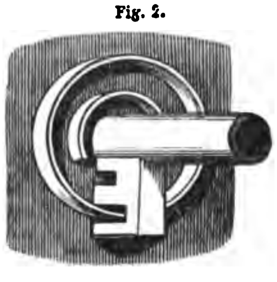
The first and simplest means by which the entrance of a false key may be rendered difficult, is by giving a peculiar form to the substance of the bit, and either adapting the form of the key-hole exactly to it, or inserting pieces of metal in the lock in such a way as to prevent the admission of a bit of different shape. *Fig.* 1 represents several forms of bit commonly used. Of these *a*, *b*, *c*, and *d* are adapted for key-holes of various corresponding forms; while *e* and *f*, though suitable for key-holes of the same general form, admit of further security by forming projections upon the sides of the key-holes.

Fig. 1.



The next and principal means of security is the use of pieces of metal of various forms, fixed within the lock in such a way that no key can be turned round within it unless corresponding notches are cut in its projecting bit. *Fig.* 2, which represents a portion of the interior of a lock, with the bit end of the key in its place, will illustrate this. Attached to the back-plate are two concentric prominent rings, of different degrees of elevation. These prominent rings are the *wards*, which impede the introduction of a false key. No key could be put into a lock provided with them, unless a notch were made in its bit to correspond with the larger of the two rings; and it is evident that no key could be turned round without having also a notch to correspond with the smaller circle. In the commoner kind of locks the wards seldom form a complete circle, but their effect is the same if they occupy only a small segment. Many wards are of a more complicated character, such as what are termed L, T, or Z wards, from the resemblance of their sectional form to those letters respectively.

Fig. 2.



The keys must, of course, be cut of a corresponding form, by which the difficulty of imitation is greatly increased.

By referring to the various forms of key represented in *Figs.* 3, 4, 5, and 6, the peculiar advantages and defects of that principle of security which depends on the use of wards, may be readily comprehended. The greatest defect of the system arises from the circumstance that, in ordinary cases, it is not absolutely necessary that a surreptitious instrument should perfectly thread the mazes of the wards. But while the wards afford security against ordinary keys, they afford none whatever against a *pick* or *skeleton key* like *k*, *Fig.* 3, which would open any of the locks suited for *g*, *h*, and *i*, the only part essential to the moving of the bolt being the extremity of the bit, which is retained in the skeleton key with nothing but a slender piece to connect it with the pipe or shank. The security may be greatly increased by the use of other wards, attached to the opposite plate of the lock, and requiring notches in that part of the bit of the key which is represented by the slender connecting piece in the skeleton *k*. Such is the case in all the keys represented in *Figs.* 4, 5, and 6. In *Fig.* 4, *l* represents a key for a solid-warded lock, which might, however, be easily picked by a skeleton key resembling *r*, *Fig.* 6. The greater complication of the wards in *m*, *Fig.* 4, increases the difficulty of picking; while by the adoption of the arrangement shown at *n*, *Fig.* 4, the difficulty of introducing a false key is made perhaps as great as possible, since no instrument that does not thread all the intricacies of the wards could answer the purpose. All the keys hitherto represented, as well as those in *Fig.* 6, are pipe-keys, adapted for such locks as have a fixed pin or axis, and can only be opened from one side. It is, therefore, of no consequence that the wards attached to the back and front plates of the lock should resemble each other. In ordinary door-locks, however, in which the key may have to be inserted from either side, it is essential that the wards attached to the two plates, if such be used, should either be precisely similar, or should bear such a relation to each other that notches may be cut in both sides, or rather edges of the bit, to suit both sets of wards; it being a necessary condition that the two sides of the bit, marked *a* and *b* in the cut, *Fig.* 5, should be perfectly alike. Our remaining illustrations of warded keys are intended to explain the theory of master keys. In *Fig.* 6, the wards of the keys *o*, *p*, and *q* are so far different from each other that neither of those three keys would open the lock designed for either of the other two; but a key formed like *r* would readily open any of the locks of the other three.

Fig. 3.

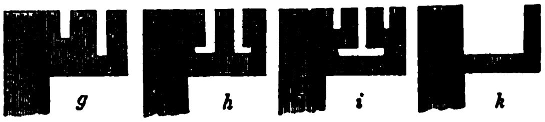


Fig. 4.

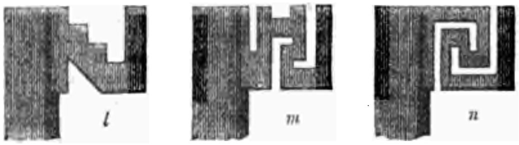


Fig. 5.

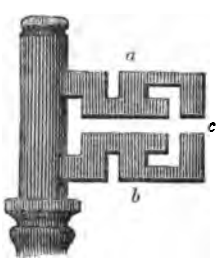
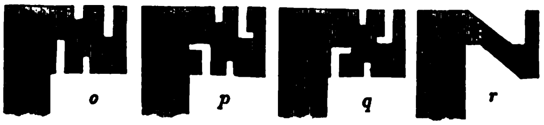


Fig. 6.



One defect of warded locks is that, however complicated they may be, an ingenious picker will mostly be able to detect their form and position, by inserting a blank key with the bit covered with wax or tallow, so as to receive an impression of the concealed obstructions in the lock. It is a very common practice to cut more notches in the key than there are wards in the lock; so that the complex appearance of a key is no certain proof of the secure construction of the lock to which it belongs. Some contrivance is necessary to keep the bolt steadily in the position in which it is left by the key; and in locks which depend upon wards for their security, this is usually effected by means of a spring, as illustrated by *Fig.* 7, which represents the interior of a small cupboard lock, with the bolt *a d b half shot*, or in a position intermediate between locking and unlocking, and capable of being moved either backwards or forwards by the action of the bit of the key at *c* in a curved hollow formed in the lower edge of the bolt. The necessary raising of the bolt and compression of the spring are properly effected by the action of the key; but as they may also be effected by pressure upon the end of the bolt, the security of locks in which such an arrangement is adopted, which are called *back-spring* locks, is much impaired.

Fig. 7.

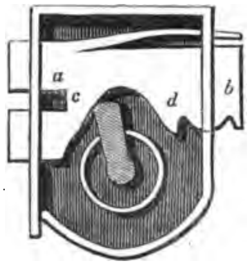
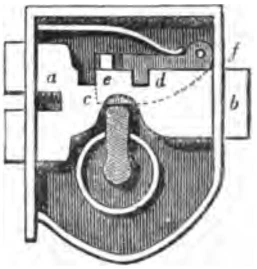


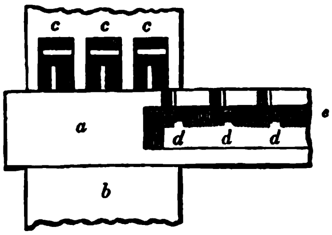
Fig. 8.



Tumbler Locks.—We pass to the explanation of the second principle of security: that which consists in the use of moveable impediments to the motion of the bolt. *Fig.* 8 represents a lock provided with a common tumbler. In this figure the bolt *a*, *b*, though shot backwards and forwards, has no spring or notches to catch on the back rim of the lock, to hold it in any required position; but it is provided with two notches in its upper edge, at *c* and *d*. Behind the bolt is a piece of metal called the *tumbler*, pivoted to the plate of the lock at *f*, and continually forced downwards by a spring which presses upon its upper edge. Near the end *e*, the tumbler carries a projecting stud, which, when the bolt is fully shot, falls into the notch *d*, and holds it firmly until, by the application of the key, the tumbler is lifted up to the position shown in the cut; by this action the bolt is released, so that the further turning of the key shoots it back, when the stud of the tumbler falls into the notch *c*, and again secures the bolt. So long as the tumbler remains in its proper notch, the bolt cannot be moved backwards or forwards by any pressure upon its ends; and the lock cannot be opened by any false key unless its bit be so formed as to reach the tumbler as well as the bolt. To render this more difficult the tumbler is often made to fall a little lower than the bolt, so as to be acted upon by a *step* formed on the bit of the key; while further security may be obtained by the use of two or more tumblers, which may be acted upon by different steps on the key. The great exactness requisite in the length of the bit forms a strong recommendation of even the commonest tumbler locks; for if the bit be ever so little too short it will not lift the tumbler out of its notch, while if it be but a very little too long, it will not enter the curved portion of the bolt.

The principle of security by tumblers has been known to the Egyptians from a very remote period. In the lock now commonly used in Egypt and Turkey, the bolt is secured by a number of pins, which fall into holes in the bolt when it is shot. In the annexed diagram, *a* is a part of the bolt, capable of sliding through the solid piece *b*, in which are a number of hollows, *c*, *c*, *c*, each containing a moveable pin. If the bolt be slid forward until the holes *d*, *d*, *d*, come under the pins *c*, *c*, *c*, the lower ends of the pins will drop into them, and the bolt will consequently be held fast. It can only be released by the application of a key which has a series of pins exactly corresponding with the holes in the bolt, and which, being introduced into the bolt is pressed upwards to lift the pins clear of it. The security arises from the concealment of the obstacles, and from the circumstance

Fig. 9.



that, even supposing a person to obtain a correct impression of the holes, it would be difficult to ascertain the exact length necessary for the bins of the key.

Notwithstanding the high antiquity of the tumbler principle, its first important application in this country appears to have been made by Barron, in 1774. In the simple form of the tumbler represented in *Fig.* 8, there is the disadvantage that, while it effectually prevents the removal of the bolt unless the tumbler be raised high enough, it presents no obstacle to its removal when the tumbler is thrown up beyond the proper degree. The defect is remedied in Barron's lock, by the use of several tumblers, each of which requires to be raised to a different degree, and any one of which, if lifted too high, will form as effectual a barrier to the motion of the bolt as if it were not lifted at all. To illustrate this, let *a*, *Fig.* 10, represent a tumbler pivoted at *b*, pressed downwards by the action of a spring at *c*, but having its downward motion limited by the contact of the tail *d* with a fixed pin. Behind the tumbler lies the bolt; and at *e* an opening, somewhat resembling the letter H in shape, is cut through the tumbler, to allow a prominent square stud, which is attached to the bolt, to pass through it. The bolt secured by such a tumbler can only be shot when the tumbler is raised precisely to such a degree as to bring the horizontal portion of the aperture opposite to the stud, so that the stud, which fits it accurately, may slip through it. *Fig.* 11 shows the tumbler raised to this position, and the bolt half shot. When fully shot the tumbler again falls; the stud is secured in that notch of the aperture which lies nearest the end of the tumbler; and an equal security is afforded against any attempt to return it to its first position by any key which does not lift it precisely to the proper height. Several such tumblers may be placed in one lock, the whole being mounted upon one pivot. *Fig.* 12 represents the bit of a key adapted for a lock with three tumblers. The lock to which this key is adapted is guarded by two wards; and the end of the bit is divided into four portions, of various degrees of projection. In the event of such a key being suspected to have fallen into wrong hands, the tumblers might be taken out and returned on to their common axis in a new order, so as to require a key in which the parts *a*, *b*, *c*, and *d*, will stand in a different relation to each other, by which means the old key will be rendered useless.

Fig. 10.

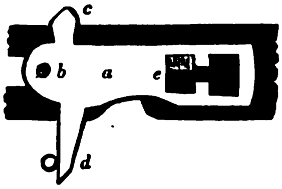


Fig. 11.

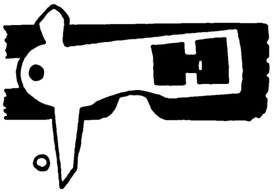
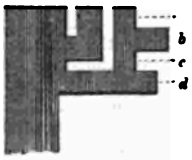


Fig. 12.



In many ingenious locks of this character the same object is attained by the use of solid tumblers, carrying studs which pass through openings in the bolt. In a lock of this description invented by Mr. Somerford, one of the tumblers is drawn downwards by the key while the others are raised, thus introducing a new complication which greatly increases the difficulty of picking, without adding materially to the cost of the lock.

Chubb's detector lock, the original patent for which was ob… ciently
1818, is one of the most celebrated locks made on the pr… red to de-
described. Its peculiar merit consists in the addition … e upon a given
the *detector*, which is so fixed that, while it does … draw the parallel
under ordinary circumstances, it cannot fail to … s of all the triangles
catch into the bolt if any one of the tumblers be … same side, the arc of
as some of them must inevitably be by any a… all the triangles havi…
thus fixing the bolt immoveably, it not only … and the arc of the …
attempt at picking the lock, but also gives … are obviously the w…
has been made, when the proper key is n… conditions; if they
In Bramah's lock, which was invente… hen the locus of all
principle of tumblers is applied in … ascertained by elem…
above described, and the use of … ore taken for granted,
ordinary mode of shooting the b… d *mechanical*. An in
key, is abandoned; the office of … TION OF THE ANGLE.
a stud attached to the end of a … curve whatever is call…
and which contains all its e… ever of that curve m…
barrel, of the actual size, dra… each of six points sh…
cut *a* represents the stud … given circle, and if no
volve on its axis, the bolt … conditions, that circle
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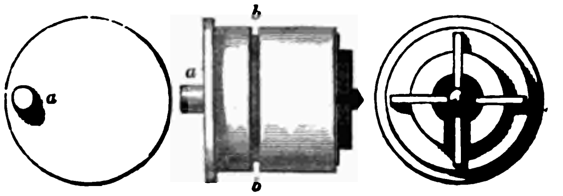
…w of landlord and tena

proper key, which is represented in *Fig.* 16, and which has a very small bit adapted to the square notch at the bottom of the key-hole

Fig. 13.



shown in the front end of the barrel; but the barrel is prevented from revolving, excepting when the proper key is applied, by a peculiar contrivance. The barrel, which contains four sliders radiating from its centre or axis, has a motion in the direction of its length; the sliders are continually pressed forward to the front or key-hole end of the barrel by a helical spring; and there is a circular plate of steel, represented in *Fig.* 14, which is cut into two halves by a division shown in the cut at top and bottom, and is inserted, by its inner edge, in the slit or opening *b b* in the barrel. The four notches in the inner edge of the plate are thus placed upon the edges of the four sliders in the barrel; and the barrel cannot be turned round unless the four sliders are so far pushed in by the key that their notches may all tally with the edge of the plate. *Fig.* 15 is a longitudinal section of the barrel with the

Fig. 14.

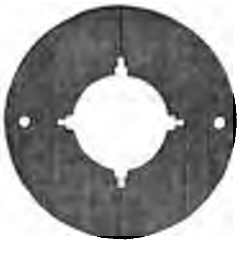


Fig. 15.

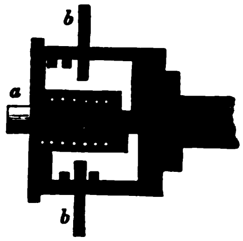
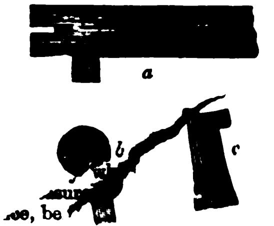


Fig. 16.



…oe, be
… water it
end of the key as applied to hi… leaves it [illegible]
for allowing the barrel … minute, th… [illegible]
file, and at *b* in an en… rately me… [illegible]
figures, aided by th… will be asc… [illegible]
this ingenious … doing, but … [illegible]
enclosed in a … many cases [illegible]
only visible … sequently th… [illegible]
hole. … is the princip… [illegible]
of wood, generally [illegible]
its arc, to make it [illegible]
fathoms long. [illegible]
twine rove [illegible]
from th… [illegible]
shor… [illegible]

The keys must, of course, be cut of a corresponding form, by which the difficulty of imitation is greatly increased.

By referring to the various forms of key represented in *Figs.* 3, 4, 5, and 6, the peculiar advantages and defects of that principle of security which depends on the use of wards, may be readily comprehended. The greatest defect of the system arises from the circumstance that, in ordinary cases, it is not absolutely necessary that a surreptitious instrument should perfectly thread the mazes of the wards. But while the wards afford security against ordinary keys, they afford none whatever against a *pick* or *skeleton key* like *k*, *Fig.* 3, which would open any of the locks suited for *g*, *h*, and *i*, the only part essential to the moving of the bolt being the extremity of the bit, which is retained in the skeleton key with nothing but a slender piece to connect it with the pipe or shank. The security may be greatly increased by the use of other wards, attached to the opposite plate of the lock, and requiring notches in that part of the bit of the key which is represented by the slender connecting piece in the skeleton *k*. Such is the case in all the keys represented in *Figs.* 4, 5, and 6. In *Fig.* 4, *l* represents a key for a solid-warded lock, which might, however, be easily picked by a skeleton key resembling *r*, *Fig.* 6. The greater complication of the wards in *m*, *Fig.* 4, increases the difficulty of picking; while by the adoption of the arrangement shown at *n*, *Fig.* 4, the difficulty of introducing a false key is made perhaps as great as possible, since no instrument that does not thread all the intricacies of the wards could answer the purpose. All the keys hitherto represented, as well as those in *Fig.* 6, are pipe-keys, adapted for such locks as have a fixed pin or axis, and can only be opened from one side. It is, therefore, of no consequence that the wards attached to the back and front plates of the lock should resemble each other. In ordinary door-locks, however, in which the key may have to be inserted from either side, it is essential that the wards attached to the two plates, if such be used, should either be precisely similar, or should bear such a relation to each other that notches may be cut in both sides, or rather edges of the bit, to suit both sets of wards; it being a necessary condition that the two sides of the bit, marked *a* and *b* in the cut, *Fig.* 5, should be perfectly alike. Our remaining illustrations of warded keys are intended to explain the theory of master keys. In *Fig.* 6, the wards of the keys *o*, *p*, and *q* are so far different from each other that neither of those three keys would open the lock designed for either of the other two; but a key formed like *r* would readily open any of the locks of the other three.

Fig. 3.

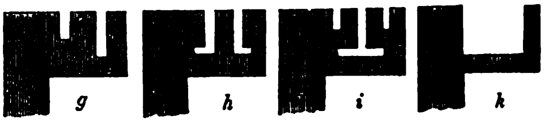


Fig. 4.

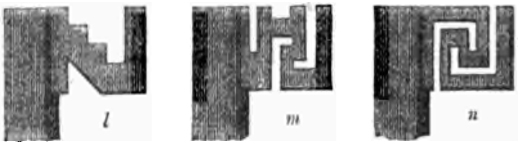


Fig. 5.

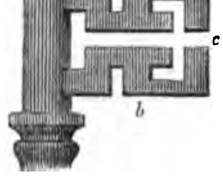
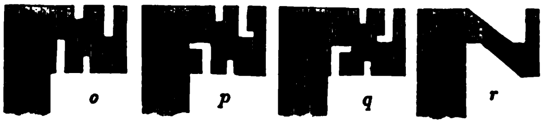


Fig. 6.



One defect of warded locks is that, however complicated they may be, an ingenious picker will mostly be able to detect their form and position, by inserting a blank key with the bit covered with wax or tallow, so as to receive an impression of the concealed obstructions in the lock. It is a very common practice to cut more notches in the key than there are wards in the lock; so that the complex appearance of a key is no certain proof of the secure construction of the lock to which it belongs. Some contrivance is necessary to keep the bolt steadily in the position in which it is left by the key; and in locks which depend upon wards for their security, this is usually effected by means of a spring, as illustrated by *Fig.* 7, which represents the interior of a small cupboard lock, with the bolt *a d b half shot*, or in a position intermediate between locking and unlocking, and capable of being moved either backwards or forwards by the action of the bit of the key at *c* in a curved hollow formed in the lower edge of the bolt. The necessary raising of the bolt and compression of the spring are properly effected by the action of the key; but as they may also be effected by pressure upon the end of the bolt, the security of locks in which such an arrangement is adopted, which are called *back-spring* locks, is much impaired.

Fig. 7.

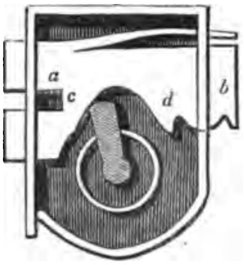
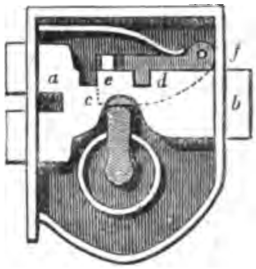


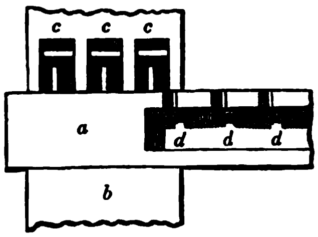
Fig. 8.



Tumbler Locks.—We pass to the explanation of the second principle of security: that which consists in the use of moveable impediments to the motion of the bolt. *Fig.* 8 represents a lock provided with a common tumbler. In this figure the bolt *a*, *b*, though shot backwards and forwards, has no spring or notches to catch on the back rim of the lock, to hold it in any required position; but it is provided with two notches in its upper edge, at *c* and *d*. Behind the bolt is a piece of metal called the *tumbler*, pivoted to the plate of the lock at *f*, and continually forced downwards by a spring which presses upon its upper edge. Near the end *e*, the tumbler carries a projecting stud, which, when the bolt is fully shot, falls into the notch *d*, and holds it firmly until, by the application of the key, the tumbler is lifted up to the position shown in the cut; by this action the bolt is released, so that the further turning of the key shoots it back, when the stud of the tumbler falls into the notch *c*, and again secures the bolt. So long as the tumbler remains in its proper notch, the bolt cannot be moved backwards or forwards by any pressure upon its ends; and the lock cannot be opened by any false key unless its bit be so formed as to reach the tumbler as well as the bolt. To render this more difficult the tumbler is often made to fall a little lower than the bolt, so as to be acted upon by a *step* formed on the bit of the key; while further security may be obtained by the use of two or more tumblers, which may be acted upon by different steps on the key. The great exactness requisite in the length of the bit forms a strong recommendation of even the commonest tumbler locks; for if the bit be ever so little too short it will not lift the tumbler out of its notch, while if it be but a very little too long, it will not enter the curved portion of the bolt.

The principle of security by tumblers has been known to the Egyptians from a very remote period. In the lock now commonly used in Egypt and Turkey, the bolt is secured by a number of pins, which fall into holes in the bolt when it is shot. In the annexed diagram, *a* is a part of the bolt, capable of sliding through the solid piece *b*, in which are a number of hollows, *c*, *c*, *c*, each containing a moveable pin. If the bolt be slid forward until the holes *d*, *d*, *d*, come under the pins *c*, *c*, *c*, the lower ends of the pins will drop into them, and the bolt will consequently be held fast. It can only be released by the application of a key which has a series of pins exactly corresponding with the holes in the bolt, and which, being introduced into the bolt is pressed upwards to lift the pins clear of it. The security arises from the concealment of the obstacles, and from the circumstance

Fig. 9.



that, even supposing a person to obtain a correct impression of the holes, it would be difficult to ascertain the exact length necessary for the bins of the key.

Notwithstanding the high antiquity of the tumbler principle, its first important application in this country appears to have been made by Barron, in 1774. In the simple form of the tumbler represented in *Fig.* 8, there is the disadvantage that, while it effectually prevents the removal of the bolt unless the tumbler be raised high enough, it presents no obstacle to its removal when the tumbler is thrown up beyond the proper degree. The defect is remedied in Barron's lock, by the use of several tumblers, each of which requires to be raised to a different degree, and any one of which, if lifted too high, will form as effectual a barrier to the motion of the bolt as if it were not lifted at all. To illustrate this, let *a*, *Fig.* 10, represent a tumbler pivoted at *b*, pressed downwards by the action of a spring at *c*, but having its downward motion limited by the contact of the tail *d* with a fixed pin. Behind the tumbler lies the bolt; and at *e* an opening, somewhat resembling the letter H in shape, is cut through the tumbler, to allow a prominent square stud, which is attached to the bolt, to pass through it. The bolt secured by such a tumbler can only be shot when the tumbler is raised precisely to such a degree as to bring the horizontal portion of the aperture opposite to the stud, so that the stud, which fits it accurately, may slip through it. *Fig.* 11 shows the tumbler raised to this position, and the bolt half shot. When fully shot the tumbler again falls; the stud is secured in that notch of the aperture which lies nearest the end of the tumbler; and an equal security is afforded against any attempt to return it to its first position by any key which does not lift it precisely to the proper height. Several such tumblers may be placed in one lock, the whole being mounted upon one pivot. *Fig.* 12 represents the bit of a key adapted for a lock with three tumblers. The lock to which this key is adapted is guarded by two wards; and the end of the bit is divided into four portions, of various degrees of projection. In the event of such a key being suspected to have fallen into wrong hands, the tumblers might be taken out and returned on to their common axis in a new order, so as to require a key in which the parts *a*, *b*, *c*, and *d*, will stand in a different relation to each other, by which means the old key will be rendered useless.

Fig. 10.

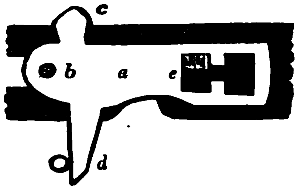


Fig. 11.

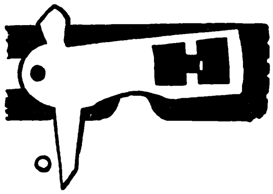
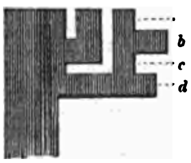


Fig. 12.



In many ingenious locks of this character the same object is attained by the use of solid tumblers, carrying studs which pass through openings in the bolt. In a lock of this description invented by Mr. Somerford, one of the tumblers is drawn downwards by the key while the others are raised, thus introducing a new complication which greatly increases the difficulty of picking, without adding materially to the cost of the lock.

Chubb's detector lock, the original patent for which was obtained in 1818, is one of the most celebrated locks made on the principle above described. Its peculiar merit consists in the addition of a lever, called the *detector*, which is so fixed that, while it does not affect the bolt under ordinary circumstances, it cannot fail to move so as to drop a catch into the bolt if any one of the tumblers be lifted a little too high, as some of them must inevitably be by any attempt at picking. By thus fixing the bolt immoveably, it not only renders useless any further attempt at picking the lock, but also gives notice of the attempt which has been made, when the proper key is next applied.

In Bramah's lock, which was invented and patented about 1784, the principle of tumblers is applied in a very different manner to that above described, and the use of wards is entirely abandoned. The ordinary mode of shooting the bolt, by the action of the bit of the key, is abandoned; the office of the end of the bit being performed by a stud attached to the end of a cylindrical barrel mounted in the lock, and which contains all its essential parts. *Fig.* 13 represents this barrel, of the actual size, drawn from a street-door latch-lock. In this cut *a* represents the stud by which, when the barrel is caused to revolve on its axis, the bolt is moved as by the bit of an ordinary key. This revolving motion is imparted to the barrel by the insertion of the proper key, which is represented in *Fig.* 16, and which has a very small bit adapted to the square notch at the bottom of the key-hole shown in the front end of the barrel; but the barrel is prevented from revolving, excepting when the proper key is applied, by a peculiar contrivance. The barrel, which contains four sliders radiating from its centre or axis, has a motion in the direction of its length; the sliders are continually pressed forward to the front or key-hole end of the barrel by a helical spring; and there is a circular plate of steel, represented in *Fig.* 14, which is cut into two halves by a division shown in the cut at top and bottom, and is inserted, by its inner edge, in the slit or opening *b b* in the barrel. The four notches in the inner edge of the plate are thus placed upon the edges of the four sliders in the barrel; and the barrel cannot be turned round unless the four sliders are so far pushed in by the key that their notches may all tally with the edge of the plate. *Fig.* 15 is a longitudinal section of the barrel with the end of the key as applied to bring the sliders into the required position for allowing the barrel to turn; and *Fig.* 16 represents, at *a* in profile, and at *b* in an end view, the key itself separately. The several figures, aided by the foregoing description, will show the mode in which this ingenious lock acts. The whole of the apparatus is securely enclosed in a turned brass box, so that even the ends of the sliders are only visible at the farther extremity of the deep and very small key-hole. To prevent the sliders from working too loose, or from dropping too far into the barrel, they are made of a thin piece of metal doubled, as shown at *c*, *Fig.* 16; so that their inner ends, having an inclination to spring open, press with sufficient force against the sides of the grooves in which they slide to keep them in position until the pressure of the key is withdrawn, and they are exposed to the counter pressure of the helical spring. The two additional small notches represented in the tumblers of *Fig.* 15 and 16, add greatly to the security of this kind of lock.

Fig. 13.

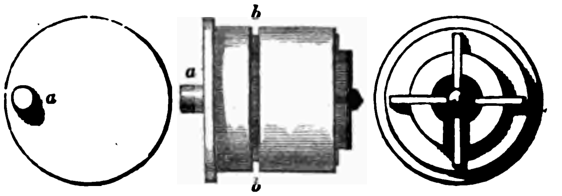


Fig. 14.

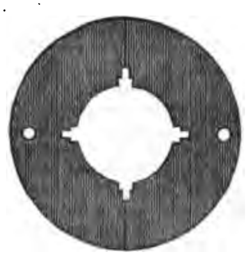


Fig. 15.

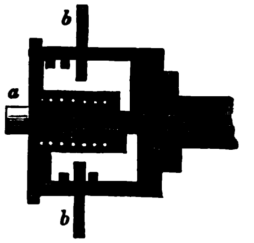
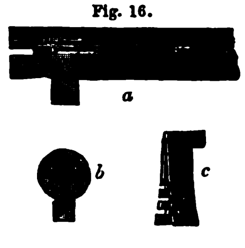


Fig. 16.



The variety attainable in the arrangement of locks on this principle forms one of its great recommendations. Our illustrations refer to one of its simplest forms; but even in this form the variety attainable, without any difference in the size of the key, is very great. By the use, however, of more sliders, the number of different locks, each of which may have the same external appearance, but can be opened only by its own proper key, is increased almost to infinity. Bramah showed that if twelve sliders were employed, the number of changes which might be produced by simply varying their relative positions would amount to 479,001,500; while by adding one more slider the number would be increased to 6,227,019,500. In the event of a key being lost, or the owner desiring to have a lock altered, it is possible to change the relative positions of the sliders, so as to render the old key useless. *Master-keys* may also be made by constructing a suit of locks alike in everything but the position of their notches, and then applying to each of them in succession the master-key, which must have notches differ-

The keys must, of course, be cut of a corresponding form, by which the difficulty of imitation is greatly increased.

By referring to the various forms of key represented in *Figs.* 3, 4, 5, and 6, the peculiar advantages and defects of that principle of security which depends on the use of wards, may be readily comprehended. The greatest defect of the system arises from the circumstance that, in ordinary cases, it is not absolutely necessary that a surreptitious instrument should perfectly thread the mazes of the wards. But while the wards afford security against ordinary keys, they afford none whatever against a *pick* or *skeleton key* like *k*, *Fig.* 3, which would open any of the locks suited for *g*, *h*, and *i*, the only part essential to the moving of the bolt being the extremity of the bit, which is retained in the skeleton key with nothing but a slender piece to connect it with the pipe or shank. The security may be greatly increased by the use of other wards, attached to the opposite plate of the lock, and requiring notches in that part of the bit of the key which is represented by the slender connecting piece in the skeleton *k*. Such is the case in all the keys represented in *Figs.* 4, 5, and 6. In *Fig.* 4, *l* represents a key for a solid-warded lock, which might, however, be easily picked by a skeleton key resembling *r*, *Fig.* 6. The greater complication of the wards in *m*, *Fig.* 4, increases the difficulty of picking; while by the adoption of the arrangement shown at *n*, *Fig.* 4, the difficulty of introducing a false key is made perhaps as great as possible, since no instrument that does not thread all the intricacies of the wards could answer the purpose. All the keys hitherto represented, as well as those in *Fig.* 6, are pipe-keys, adapted for such locks as have a fixed pin or axis, and can only be opened from one side. It is, therefore, of no consequence that the wards attached to the back and front plates of the lock should resemble each other. In ordinary door-locks, however, in which the key may have to be inserted from either side, it is essential that the wards attached to the two plates, if such be used, should either be precisely similar, or should bear such a relation to each other that notches may be cut in both sides, or rather edges of the bit, to suit both sets of wards; it being a necessary condition that the two sides of the bit, marked *a* and *b* in the cut, *Fig.* 5, should be perfectly alike. Our remaining illustrations of warded keys are intended to explain the theory of master keys. In *Fig.* 6, the wards of the keys *o*, *p*, and *q* are so far different from each other that neither of those three keys would open the lock designed for either of the other two; but a key formed like *r* would readily open any of the locks of the other three.

Fig. 3.

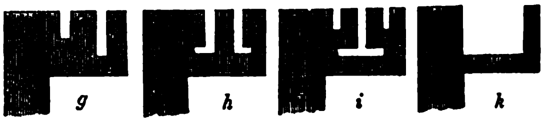


Fig. 4.

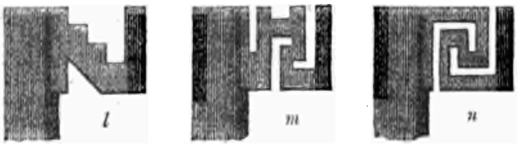


Fig. 5.

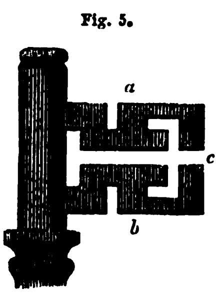
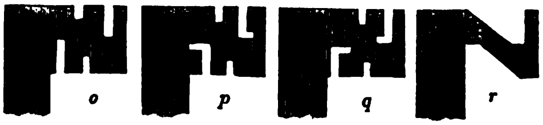


Fig. 6.



One defect of warded locks is that, however complicated they may be, an ingenious picker will mostly be able to detect their form and position, by inserting a blank key with the bit covered with wax or tallow, so as to receive an impression of the concealed obstructions in the lock. It is a very common practice to cut more notches in the key than there are wards in the lock; so that the complex appearance of a key is no certain proof of the secure construction of the lock to which it belongs. Some contrivance is necessary to keep the bolt steadily in the position in which it is left by the key; and in locks which depend upon wards for their security, this is usually effected by means of a spring, as illustrated by *Fig.* 7, which represents the interior of a small cupboard lock, with the bolt *a d b half shot*, or in a position intermediate between locking and unlocking, and capable of being moved either backwards or forwards by the action of the bit of the key at *c* in a curved hollow formed in the lower edge of the bolt. The necessary raising of the bolt and compression of the spring are properly effected by the action of the key; but as they may also be effected by pressure upon the end of the bolt, the security of locks in which such an arrangement is adopted, which are called *back-spring* locks, is much impaired.

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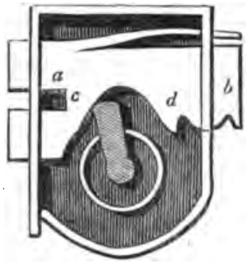

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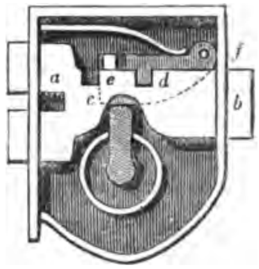

Tumbler Locks.—We pass to the explanation of the second principle of security: that which consists in the use of moveable impediments to the motion of the bolt. *Fig.* 8 represents a lock provided with a common tumbler. In this figure the bolt *a*, *b*, though shot backwards and forwards, has no spring or notches to catch on the back rim of the lock, to hold it in any required position; but it is provided with two notches in its upper edge, at *c* and *d*. Behind the bolt is a piece of metal called the *tumbler*, pivoted to the plate of the lock at *f*, and continually forced downwards by a spring which presses upon its upper edge. Near the end *e*, the tumbler carries a projecting stud, which, when the bolt is fully shot, falls into the notch *d*, and holds it firmly until, by the application of the key, the tumbler is lifted up to the position shown in the cut; by this action the bolt is released, so that the further turning of the key shoots it back, when the stud of the tumbler falls into the notch *c*, and again secures the bolt. So long as the tumbler remains in its proper notch, the bolt cannot be moved backwards or forwards by any pressure upon its ends; and the lock cannot be opened by any false key unless its bit be so formed as to reach the tumbler as well as the bolt. To render this more difficult the tumbler is often made to fall a little lower than the bolt, so as to be acted upon by a *step* formed on the bit of the key; while further security may be obtained by the use of two or more tumblers, which may be acted upon by different steps on the key. The great exactness requisite in the length of the bit forms a strong recommendation of even the commonest tumbler locks; for if the bit be ever so little too short it will not lift the tumbler out of its notch, while if it be but a very little too long, it will not enter the curved portion of the bolt.

The principle of security by tumblers has been known to the Egyptians from a very remote period. In the lock now commonly used in Egypt and Turkey, the bolt is secured by a number of pins, which fall into holes in the bolt when it is shot. In the annexed diagram, *a* is a part of the bolt, capable of sliding through the solid piece *b*, in which are a number of hollows, *c*, *c*, *c*, each containing a moveable pin. If the bolt be slid forward until the holes *d*, *d*, *d*, come under the pins *c*, *c*, *c*, the lower ends of the pins will drop into them, and the bolt will consequently be held fast. It can only be released by the application of a key which has a series of pins exactly corresponding with the holes in the bolt, and which, being introduced into the bolt is pressed upwards to lift the pins clear of it. The security arises from the concealment of the obstacles, and from the circumstance

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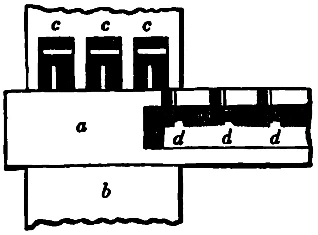

that, even supposing a person to obtain a correct impression of the holes, it would be difficult to ascertain the exact length necessary for the pins of the key.

Notwithstanding the high antiquity of the tumbler principle, its first important application in this country appears to have been made by Barron, in 1774. In the simple form of the tumbler represented in *Fig.* 8, there is the disadvantage that, while it effectually prevents the removal of the bolt unless the tumbler be raised high enough, it presents no obstacle to its removal when the tumbler is thrown up beyond the proper degree. The defect is remedied in Barron's lock, by the use of several tumblers, each of which requires to be raised to a different degree, and any one of which, if lifted too high, will form as effectual a barrier to the motion of the bolt as if it were not lifted at all. To illustrate this, let *a*, *Fig.* 10, represent a tumbler pivoted at *b*, pressed downwards by the action of a spring at *c*, but having its downward motion limited by the contact of the tail *d* with a fixed pin. Behind the tumbler lies the bolt; and at *e* an opening, somewhat resembling the letter H in shape, is cut through the tumbler, to allow a prominent square stud, which is attached to the bolt, to pass through it. The bolt secured by such a tumbler can only be shot when the tumbler is raised precisely to such a degree as to bring the horizontal portion of the aperture opposite to the stud, so that the stud, which fits it accurately, may slip through it. *Fig.* 11 shows the tumbler raised to this position, and the bolt half shot. When fully shot the tumbler again falls; the stud is secured in that notch of the aperture which lies nearest the end of the tumbler; and an equal security is afforded against any attempt to return it to its first position by any key which does not lift it precisely to the proper height. Several such tumblers may be placed in one lock, the whole being mounted upon one pivot. *Fig.* 12 represents the bit of a key adapted for a lock with three tumblers. The lock to which this key is adapted is guarded by two wards; and the end of the bit is divided into four portions, of various degrees of projection. In the event of such a key being suspected to have fallen into wrong hands, the tumblers might be taken out and returned on to their common axis in a new order, so as to require a key in which the parts *a*, *b*, *c*, and *d*, will stand in a different relation to each other, by which means the old key will be rendered useless.

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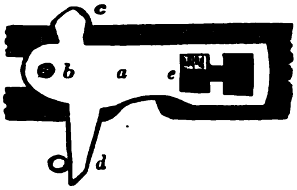

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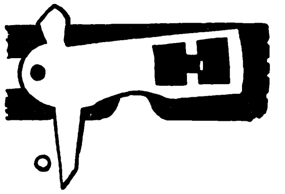

Fig. 12.

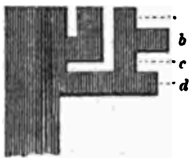

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Fig. 13.

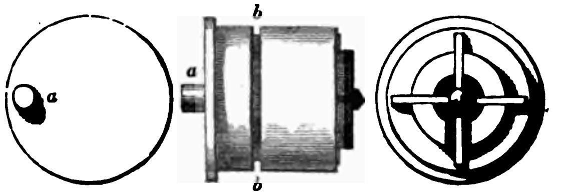


Fig. 14.

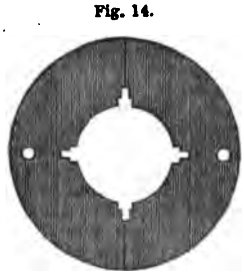


Fig. 15.

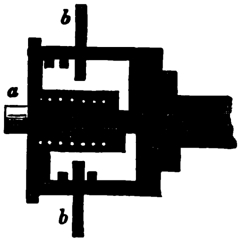
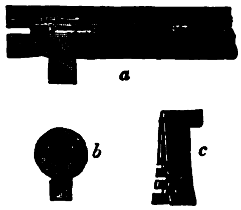


Fig. 16.



The variety attainable in the arrangement of locks on this principle forms one of its great recommendations. Our illustrations refer to one of its simplest forms; but even in this form the variety attainable, without any difference in the size of the key, is very great. By the use, however, of more sliders, the number of different locks, each of which may have the same external appearance, but can be opened only by its own proper key, is increased almost to infinity. Bramah showed that if twelve sliders were employed, the number of changes which might be produced by simply varying their relative positions would amount to 479,001,600; while by adding one more slider the number would be increased to 6,227,019,500. In the event of a key being lost, or the owner desiring to have a lock altered, it is possible to change the relative positions of the sliders, so as to render the old key useless. *Master-keys* may also be made by constructing a suit of locks alike in everything but the position of their notches, and then applying to each of them in succession the master-key, which must have notches differ-

The keys must, of course, be cut of a corresponding form, by which the difficulty of imitation is greatly increased.

By referring to the various forms of key represented in *Figs.* 3, 4, 5, and 6, the peculiar advantages and defects of that principle of security which depends on the use of wards, may be readily comprehended. The greatest defect of the system arises from the circumstance that, in ordinary cases, it is not absolutely necessary that a surreptitious instrument should perfectly thread the mazes of the wards. But while the wards afford security against ordinary keys, they afford none whatever against a *pick* or *skeleton key* like *k*, *Fig.* 3, which would open any of the locks suited for *g*, *h*, and *i*, the only part essential to the moving of the bolt being the extremity of the bit, which is retained in the skeleton key with nothing but a slender piece to connect it with the pipe or shank. The security may be greatly increased by the use of other wards, attached to the opposite plate of the lock, and requiring notches in that part of the bit of the key which is represented by the slender connecting piece in the skeleton *k*. Such is the case in all the keys represented in *Figs.* 4, 5, and 6. In *Fig.* 4, *l* represents a key for a solid-warded lock, which might, however, be easily picked by a skeleton key resembling *r*, *Fig.* 6. The greater complication of the wards in *m*, *Fig.* 4, increases the difficulty of picking; while by the adoption of the arrangement shown at *n*, *Fig.* 4, the difficulty of introducing a false key is made perhaps as great as possible, since no instrument that does not thread all the intricacies of the wards could answer the purpose. All the keys hitherto represented, as well as those in *Fig.* 6, are pipe-keys, adapted for such locks as have a fixed pin or axis, and can only be opened from one side. It is, therefore, of no consequence that the wards attached to the back and front plates of the lock should resemble each other. In ordinary door-locks, however, in which the key may have to be inserted from either side, it is essential that the wards attached to the two plates, if such be used, should either be precisely similar, or should bear such a relation to each other that notches may be cut in both sides, or rather edges of the bit, to suit both sets of wards; it being a necessary condition that the two sides of the bit, marked *a* and *b* in the cut, *Fig.* 5, should be perfectly alike. Our remaining illustrations of warded keys are intended to explain the theory of master keys. In *Fig.* 6, the wards of the keys *o*, *p*, and *q* are so far different from each other that neither of those three keys would open the lock designed for either of the other two; but a key formed like *r* would readily open any of the locks of the other three.

Fig. 3.

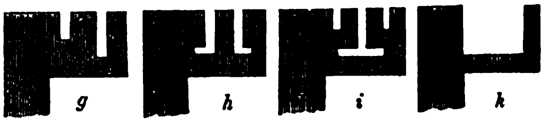


Fig. 4.

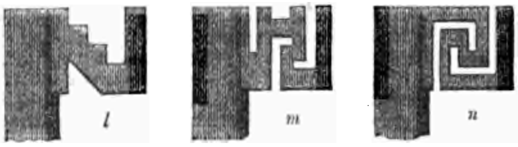


Fig. 5.

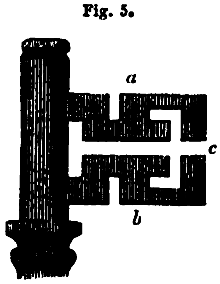
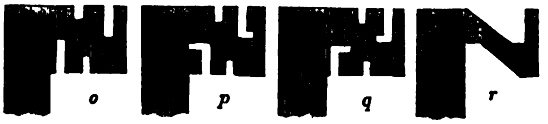


Fig. 6.



One defect of warded locks is that, however complicated they may be, an ingenious picker will mostly be able to detect their form and position, by inserting a blank key with the bit covered with wax or tallow, so as to receive an impression of the concealed obstructions in the lock. It is a very common practice to cut more notches in the key than there are wards in the lock; so that the complex appearance of a key is no certain proof of the secure construction of the lock to which it belongs. Some contrivance is necessary to keep the bolt steadily in the position in which it is left by the key; and in locks which depend upon wards for their security, this is usually effected by means of a spring, as illustrated by *Fig.* 7, which represents the interior of a small cupboard lock, with the bolt *a d b half shot*, or in a position intermediate between locking and unlocking, and capable of being moved either backwards or forwards by the action of the bit of the key at *c* in a curved hollow formed in the lower edge of the bolt. The necessary raising of the bolt and compression of the spring are properly effected by the action of the key; but as they may also be effected by pressure upon the end of the bolt, the security of locks in which such an arrangement is adopted, which are called *back-spring* locks, is much impaired.

Fig. 7.

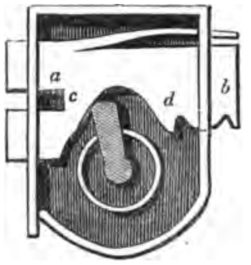
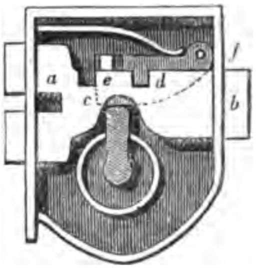


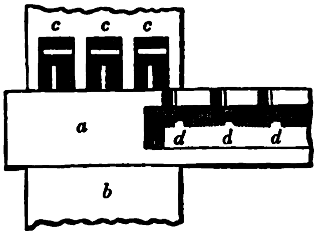
Fig. 8.



Tumbler Locks.—We pass to the explanation of the second principle of security: that which consists in the use of moveable impediments to the motion of the bolt. *Fig.* 8 represents a lock provided with a common tumbler. In this figure the bolt *a*, *b*, though shot backwards and forwards, has no spring or notches to catch on the back rim of the lock, to hold it in any required position; but it is provided with two notches in its upper edge, at *c* and *d*. Behind the bolt is a piece of metal called the *tumbler*, pivoted to the plate of the lock at *f*, and continually forced downwards by a spring which presses upon its upper edge. Near the end *e*, the tumbler carries a projecting stud, which, when the bolt is fully shot, falls into the notch *d*, and holds it firmly until, by the application of the key, the tumbler is lifted up to the position shown in the cut; by this action the bolt is released, so that the further turning of the key shoots it back, when the stud of the tumbler falls into the notch *c*, and again secures the bolt. So long as the tumbler remains in its proper notch, the bolt cannot be moved backwards or forwards by any pressure upon its ends; and the lock cannot be opened by any false key unless its bit be so formed as to reach the tumbler as well as the bolt. To render this more difficult the tumbler is often made to fall a little lower than the bolt, so as to be acted upon by a *step* formed on the bit of the key; while further security may be obtained by the use of two or more tumblers, which may be acted upon by different steps on the key. The great exactness requisite in the length of the bit forms a strong recommendation of even the commonest tumbler locks; for if the bit be ever so little too short it will not lift the tumbler out of its notch, while if it be but a very little too long, it will not enter the curved portion of the bolt.

The principle of security by tumblers has been known to the Egyptians from a very remote period. In the lock now commonly used in Egypt and Turkey, the bolt is secured by a number of pins, which fall into holes in the bolt when it is shot. In the annexed diagram, *a* is a part of the bolt, capable of sliding through the solid piece *b*, in which are a number of hollows, *c*, *c*, *c*, each containing a moveable pin. If the bolt be slid forward until the holes *d*, *d*, *d*, come under the pins *c*, *c*, *c*, the lower ends of the pins will drop into them, and the bolt will consequently be held fast. It can only be released by the application of a key which has a series of pins exactly corresponding with the holes in the bolt, and which, being introduced into the bolt is pressed upwards to lift the pins clear of it. The security arises from the concealment of the obstacles, and from the circumstance

Fig. 9.



that, even supposing a person to obtain a correct impression of the holes, it would be difficult to ascertain the exact length necessary for the bins of the key.

Notwithstanding the high antiquity of the tumbler principle, its first important application in this country appears to have been made by **Barron**, in 1774. In the simple form of the tumbler represented in *Fig.* 8, there is the disadvantage that, while it effectually prevents the removal of the bolt unless the tumbler be raised high enough, it presents no obstacle to its removal when the tumbler is thrown up beyond the proper degree. The defect is remedied in Barron's lock, by the use of several tumblers, each of which requires to be raised to a different degree, and any one of which, if lifted too high, will form as effectual a barrier to the motion of the bolt as if it were not lifted at all. To illustrate this, let *a*, *Fig.* 10, represent a tumbler pivoted at *b*, pressed downwards by the action of a spring at *c*, but having its downward motion limited by the contact of the tail *d* with a fixed pin. Behind the tumbler lies the bolt; and at *e* an opening, somewhat resembling the letter H in shape, is cut through the tumbler, to allow a prominent square stud, which is attached to the bolt, to pass through it. The bolt secured by such a tumbler can only be shot when the tumbler is raised precisely to such a degree as to bring the horizontal portion of the aperture opposite to the stud, so that the stud, which fits it accurately, may slip through it. *Fig.* 11 shows the tumbler raised to this position, and the bolt half shot. When fully shot the tumbler again falls; the stud is secured in that notch of the aperture which lies nearest the end of the tumbler; and an equal security is afforded against any attempt to return it to its first position by any key which does not lift it precisely to the proper height. Several such tumblers may be placed in one lock, the whole being mounted upon one pivot. *Fig.* 12 represents the bit of a key adapted for a lock with three tumblers. The lock to which this key is adapted is guarded by two wards; and the end of the bit is divided into four portions, of various degrees of projection. In the event of such a key being suspected to have fallen into wrong hands, the tumblers might be taken out and returned on to their common axis in a new order, so as to require a key in which the parts *a*, *b*, *c*, and *d*, will stand in a different relation to each other, by which means the old key will be rendered useless.

Fig. 10.

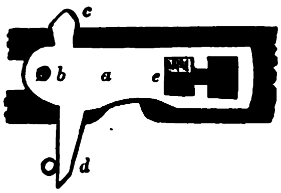


Fig. 11.

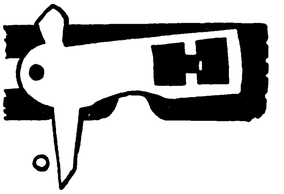
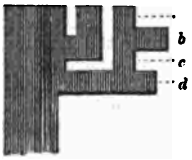


Fig. 12.



In many ingenious locks of this character the same object is attained by the use of solid tumblers, carrying studs which pass through openings in the bolt. In a lock of this description invented by Mr. Somerford, one of the tumblers is drawn downwards by the key while the others are raised, thus introducing a new complication which greatly increases the difficulty of picking, without adding materially to the cost of the lock.

Chubb's detector lock, the original patent for which was obtained in 1818, is one of the most celebrated locks made on the principle above described. Its peculiar merit consists in the addition of a lever, called the *detector*, which is so fixed that, while it does not affect the bolt under ordinary circumstances, it cannot fail to move so as to drop a catch into the bolt if any one of the tumblers be lifted a little too high, as some of them must inevitably be by any attempt at picking. By thus fixing the bolt immoveably, it not only renders useless any further attempt at picking the lock, but also gives notice of the attempt which has been made, when the proper key is next applied.

In Bramah's lock, which was invented and patented about 1784, the principle of tumblers is applied in a very different manner to that above described, and the use of wards is entirely abandoned. The ordinary mode of shooting the bolt, by the action of the bit of the key, is abandoned; the office of the end of the bit being performed by a stud attached to the end of a cylindrical barrel mounted in the lock, and which contains all its essential parts. *Fig.* 13 represents this barrel, of the actual size, drawn from a street-door latch-lock. In this cut *a* represents the stud by which, when the barrel is caused to revolve on its axis, the bolt is moved as by the bit of an ordinary key. This revolving motion is imparted to the barrel by the insertion of the proper key, which is represented in *Fig.* 16, and which has a very small bit adapted to the square notch at the bottom of the key-hole shown in the front end of the barrel; but the barrel is prevented from revolving, excepting when the proper key is applied, by a peculiar contrivance. The barrel, which contains four sliders radiating from its centre or axis, has a motion in the direction of its length; the sliders are continually pressed forward to the front or key-hole end of the barrel by a helical spring; and there is a circular plate of steel, represented in *Fig.* 14, which is cut into two halves by a division shown in the cut at top and bottom, and is inserted, by its inner edge, in the slit or opening *b b* in the barrel. The four notches in the inner edge of the plate are thus placed upon the edges of the four sliders in the barrel; and the barrel cannot be turned round unless the four sliders are so far pushed in by the key that their notches may all tally with the edge of the plate. *Fig.* 15 is a longitudinal section of the barrel with the end of the key as applied to bring the sliders into the required position for allowing the barrel to turn; and *Fig.* 16 represents, at *a* in profile, and at *b* in an end view, the key itself separately. The several figures, aided by the foregoing description, will show the mode in which this ingenious lock acts. The whole of the apparatus is securely enclosed in a turned brass box, so that even the ends of the sliders are only visible at the farther extremity of the deep and very small key-hole. To prevent the sliders from working too loose, or from dropping too far into the barrel, they are made of a thin piece of metal doubled, as shown at *c*, *Fig.* 16; so that their inner ends, having an inclination to spring open, press with sufficient force against the sides of the grooves in which they slide to keep them in position until the pressure of the key is withdrawn, and they are exposed to the counter pressure of the helical spring. The two additional small notches represented in the tumblers of *Fig.* 15 and 16, add greatly to the security of this kind of lock.

Fig. 13.

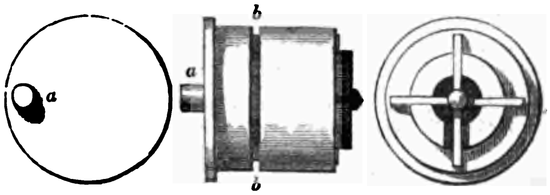


Fig. 14.

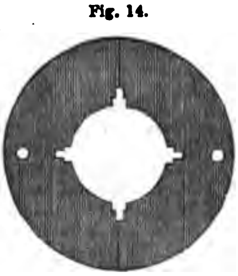
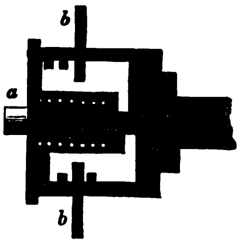


Fig. 15.



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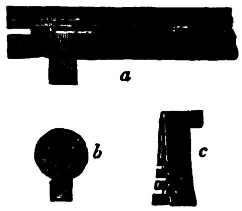

The variety attainable in the arrangement of locks on this principle forms one of its great recommendations. Our illustrations refer to one of its simplest forms; but even in this form the variety attainable, without any difference in the size of the key, is very great. By the use, however, of more sliders, the number of different locks, each of which may have the same external appearance, but can be opened only by its own proper key, is increased almost to infinity. Bramah showed that if twelve sliders were employed, the number of changes which might be produced by simply varying their relative positions would amount to 479,001,600; while by adding one more slider the number would be increased to 6,227,019,600. In the event of a key being lost, or the owner desiring to have a lock altered, it is possible to change the relative positions of the sliders, so as to render the old key useless. *Master-keys* may also be made by constructing a suit of locks alike in everything but the position of their notches, and then applying to each of them in succession the master-key, which must have notches differ-

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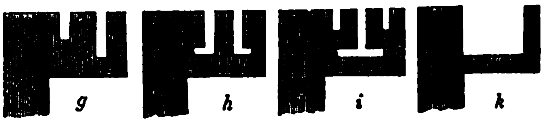

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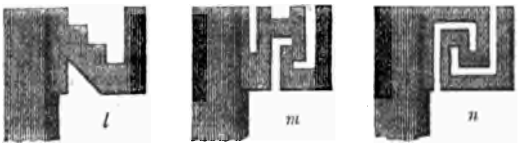

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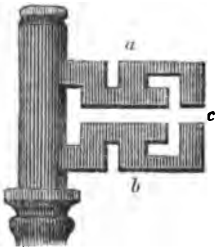
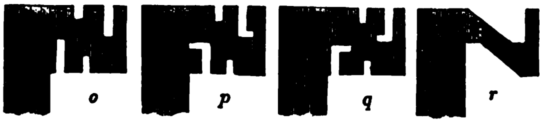


Fig. 6.



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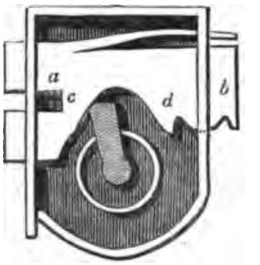

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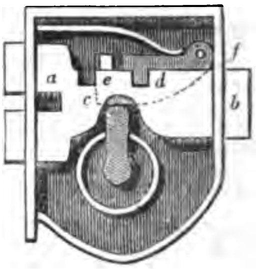

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The principle of security by tumblers has been known to the Egyptians from a very remote period. In the lock now commonly used in Egypt and Turkey, the bolt is secured by a number of pins, which fall into holes in the bolt when it is shot. In the annexed diagram, *a* is a part of the bolt, capable of sliding through the solid piece *b*, in which are a number of hollows, *c, c, c,* each containing a moveable pin. If the bolt be slid forward until the holes *d, d, d,* come under the pins *c, c, c,* the lower ends of the pins will drop into them, and the bolt will consequently be held fast. It can only be released by the application of a key which has a series of pins exactly corresponding with the holes in the bolt, and which, being introduced into the bolt is pressed upwards to lift the pins clear of it. The security arises from the concealment of the obstacles, and from the circumstance

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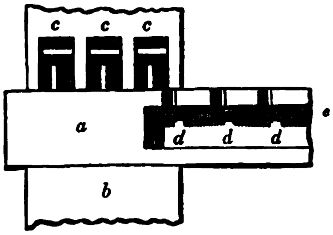


that, even supposing a person to obtain a correct impression of the holes, it would be difficult to ascertain the exact length necessary for the bits of the key.

Notwithstanding the high antiquity of the tumbler principle, its first important application in this country appears to have been made by Barron, in 1774. In the simple form of the tumbler represented in *Fig.* 8, there is the disadvantage that, while it effectually prevents the removal of the bolt unless the tumbler be raised high enough, it presents no obstacle to its removal when the tumbler is thrown up beyond the proper degree. The defect is remedied in Barron's lock, by the use of several tumblers, each of which requires to be raised to a different degree, and any one of which, if lifted too high, will form as effectual a barrier to the motion of the bolt as if it were not lifted at all. To illustrate this, let *a*, *Fig.* 10, represent a tumbler pivoted at *b*, pressed downwards by the action of a spring at *c*, but having its downward motion limited by the contact of the tail *d* with a fixed pin. Behind the tumbler lies the bolt; and at *e* an opening, somewhat resembling the letter H in shape, is cut through the tumbler, to allow a prominent square stud, which is attached to the bolt, to pass through it. The bolt secured by such a tumbler can only be shot when the tumbler is raised precisely to such a degree as to bring the horizontal portion of the aperture opposite to the stud, so that the stud, which fits it accurately, may slip through it. *Fig.* 11 shows the tumbler raised to this position, and the bolt half shot. When fully shot the tumbler again falls; the stud is secured in that notch of the aperture which lies nearest the end of the tumbler; and an equal security is afforded against any attempt to return it to its first position by any key which does not lift it precisely to the proper height. Several such tumblers may be placed in one lock, the whole being mounted upon one pivot. *Fig.* 12 represents the bit of a key adapted for a lock with three tumblers. The lock to which this key is adapted is guarded by two wards; and the end of the bit is divided into four portions, of various degrees of projection. In the event of such a key being suspected to have fallen into wrong hands, the tumblers might be taken out and returned on to their common axis in a new order, so as to require a key in which the parts *a*, *b*, *c*, and *d*, will stand in a different relation to each other, by which means the old key will be rendered useless.

Fig. 10.

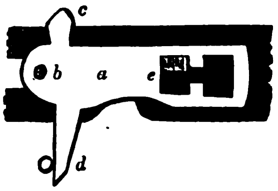


Fig. 11.

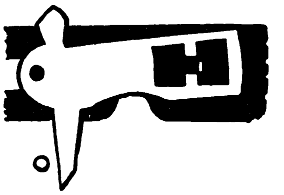
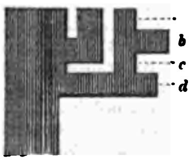


Fig. 12.



In many ingenious locks of this character the same object is attained by the use of solid tumblers, carrying studs which pass through openings in the bolt. In a lock of this description invented by Mr. Somerford, one of the tumblers is drawn downwards by the key while the others are raised, thus introducing a new complication which greatly increases the difficulty of picking, without adding materially to the cost of the lock.

Chubb's detector lock, the original patent for which was obtained in 1818, is one of the most celebrated locks made on the principle above described. Its peculiar merit consists in the addition of a lever, called the *detector*, which is so fixed that, while it does not affect the bolt under ordinary circumstances, it cannot fail to move so as to drop a catch into the bolt if any one of the tumblers be lifted a little too high, as some of them must inevitably be by any attempt at picking. By thus fixing the bolt immoveably, it not only renders useless any further attempt at picking the lock, but also gives notice of the attempt which has been made, when the proper key is next applied.

In Bramah's lock, which was invented and patented about 1784, the principle of tumblers is applied in a very different manner to that above described, and the use of wards is entirely abandoned. The ordinary mode of shooting the bolt, by the action of the bit of the key, is abandoned; the office of the end of the bit being performed by a stud attached to the end of a cylindrical barrel mounted in the lock, and which contains all its essential parts. *Fig.* 13 represents this barrel, of the actual size, drawn from a street-door latch-lock. In this cut *a* represents the stud by which, when the barrel is caused to revolve on its axis, the bolt is moved as by the bit of an ordinary key. This revolving motion is imparted to the barrel by the insertion of the proper key, which is represented in *Fig.* 16, and which has a very small bit adapted to the square notch at the bottom of the key-hole shown in the front end of the barrel; but the barrel is prevented from revolving, excepting when the proper key is applied, by a peculiar contrivance. The barrel, which contains four sliders radiating from its centre or axis, has a motion in the direction of its length; the sliders are continually pressed forward to the front or key-hole end of the barrel by a helical spring; and there is a circular plate of steel, represented in *Fig.* 14, which is cut into two halves by a division shown in the cut at top and bottom, and is inserted, by its inner edge, in the slit or opening *b b* in the barrel. The four notches in the inner edge of the plate are thus placed upon the edges of the four sliders in the barrel; and the barrel cannot be turned round unless the four sliders are so far pushed in by the key that their notches may all tally with the edge of the plate. *Fig.* 15 is a longitudinal section of the barrel with the end of the key as applied to bring the sliders into the required position for allowing the barrel to turn; and *Fig.* 16 represents, at *a* in profile, and at *b* in an end view, the key itself separately. The several figures, aided by the foregoing description, will show the mode in which this ingenious lock acts. The whole of the apparatus is securely enclosed in a turned brass box, so that even the ends of the sliders are only visible at the farther extremity of the deep and very small key-hole. To prevent the sliders from working too loose, or from dropping too far into the barrel, they are made of a thin piece of metal doubled, as shown at *c*, *Fig.* 16; so that their inner ends, having an inclination to spring open, press with sufficient force against the sides of the grooves in which they slide to keep them in position until the pressure of the key is withdrawn, and they are exposed to the counter pressure of the helical spring. The two additional small notches represented in the tumblers of *Fig.* 15 and 16, add greatly to the security of this kind of lock.

Fig. 13.

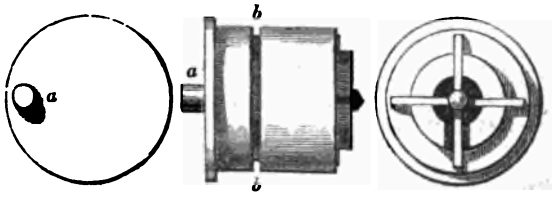


Fig. 14.

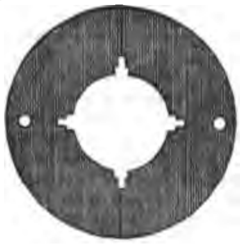


Fig. 15.

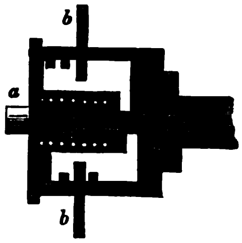
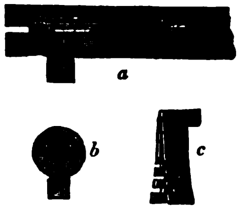


Fig. 16.



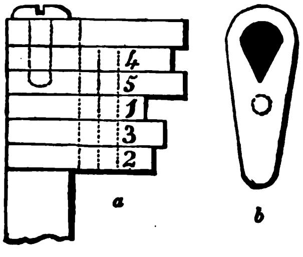
The variety attainable in the arrangement of locks on this principle forms one of its great recommendations. Our illustrations refer to one of its simplest forms; but even in this form the variety attainable, without any difference in the size of the key, is very great. By the use, however, of more sliders, the number of different locks, each of which may have the same external appearance, but can be opened only by its own proper key, is increased almost to infinity. Bramah showed that if twelve sliders were employed, the number of changes which might be produced by simply varying their relative positions would amount to 479,001,600; while by adding one more slider the number would be increased to 6,227,019,500. In the event of a key being lost, or the owner desiring to have a lock altered, it is possible to change the relative positions of the sliders, so as to render the old key useless. *Master-keys* may also be made by constructing a suit of locks alike in everything but the position of their notches, and then applying to each of them in succession the master-key, which must have notches differ-

ent to any of the ordinary keys, and cutting additional notches in the sliders to suit it.

Owing to the small size of the protecting apparatus, the Bramah lock has been applied to many ingenious purposes for which other kinds of locks are less suitable, among which we may notice the locking of liquor-cocks. Mr. Mordan afterwards invented what he calls a "lock-protector," which is, in fact a shield, adapted to cover the key-hole, and having in its centre a minute lock with seven sliders. By applying this to a key-hole on the outside of a door, and turning its key a quarter round, two lancet-shaped pieces of steel are projected from a little box, in such a manner as to dig into the wood on the opposite sides of the key-hole, and to hold the shield so firmly in its place that nothing short of the application of violence can remove it, until, by a fresh application of the little key, the blades are withdrawn. A lock was invented by Mr. Kemp, in 1816, in which the peculiarities of both Barron's and Bramah's locks are combined in such a way as to afford, in the inventor's opinion, greater security than can be attained by either alone.

Permutation Locks. Of these, the simplest is a kind of padlock termed a puzzle-lock, which opens without a key, but is regarded rather as an ingenious toy than as an available substitute for locks. In the commonest form a bar, with square or other projections, is slipped through a series of circular discs, each of which is capable of being turned round upon it as an axis. The apertures through the centre of these discs are so formed that unless the whole of them are turned round to the exact position they occupied when the bar was slipped in, it cannot be withdrawn. To provide for bringing the rings to this position the periphery of each is marked with a series of letters or numbers, a certain predetermined combination of which must be brought into a straight line by turning the several rings round with the thumb and finger. As the number of combinations which may be effected, like the number of changes in the relative positions of the sliders of a Bramah's lock, is almost infinite, while only one combination will enable a person to open the lock, a high degree of security may thus be attained. Many varieties of this lock have been invented. One, by Mr. Mackinnon, is a tumbler lock, in which each tumbler is numbered, and a corresponding number is stamped upon each of a series of small plates, which, when put together upon an axis at the end of the shank of the key, as represented in *Fig.* 17, constitute a bit resembling that of the key of an ordinary tumbler lock. Each bit is pierced with two holes, one of such a form as to fit upon the pear-shaped end of the shank, while the other is round, to receive a pin which is attached to the uppermost or end member of the bit, and which passes through all the others, as indicated by the dotted lines in *a*. A small hole in the end of the shank serves to receive a screw by which all the parts of the bit are kept firmly in their place. The end division of the bit, which is not numbered, is that intended to shoot the bolt; others, marked 1, 2, 3, 4, and 5, may be varied in position at pleasure, so as to correspond with similar changes in the positions of the tumblers, or so as to unfit the key for opening the lock. In some locks increased complexity is obtained by the use of two distinct sets of tumblers, capable of impeding each other's motion except when rightly acted upon.

Fig. 17.



Some locks have been made in which the action depends on the key being a powerful magnet. In others the difficulty of opening is increased by requiring a peculiar method of applying the key. In Lawson's lock there is a sliding curtain, by which, it is stated, "the key-hole is so perfectly closed during the act of unlocking, that it would be impossible to move the bolt while a pick remains in the aperture." In Gottlieb's lock, a piece of paper is so placed that no key can be put in without perforating it, and that it cannot be removed excepting by an application of the proper key. In Rutherford's lock, there is a stop-plate to the bolt, rendering it impossible to open the lock with its own key until, by the action of clockwork within or connected with the lock, the stop-plate should be brought into a certain position. Many contrivances have been effected for attaching an alarum to locks, by which the introduction of a false key should ring a bell or fire a pistol. The compound locks generally used for the doors of iron safes, and for similar purposes, though ponderous and complicated in appearance, are, in reality, of simple construction. Although they often throw out bolts on each side, and towards the top and bottom of the door, these are usually but so many branches of four massive pieces of iron, capable of being simultaneously projected or retracted by a handle in the centre of the door; the actual lock being but small, and merely intended to move an apparatus by which the great bolts are themselves locked; so that the key may be small in proportion to the bolts by which the door is secured. Among the useful inventions relating to street-door locks is Chubb's combination-latch, which combines the simple lifting action of the ordinary French latch, or that which opens with a handle inside the door, and with a key from without, with much of the security of a tumbler-lock.

In the above description of the three principal classes into which locks may be grouped, we have only noticed a few examples in each class to illustrate the general principle. Our limits will not permit more detailed treatment. The number of patents relating to locks is immense, and every year is adding to it. In mentioning such celebrated makers as Chubb and Bramah, we have adverted chiefly to the original patents on which their locks were constructed; but numerous patents have subsequently been obtained by the same makers, which, though adhering pretty nearly to the same principle, exhibit wide diversities in detail. The earlier patents, too, have long since run out; and many other makers now construct locks involving the essential principles of the. earlier Chubb and Bramah locks, though known by other names.

A very remarkable stimulus was given both to the invention and the manufacture of locks by occurrences which arose out of the Great Exhibition of 1851. Until that year, American locks were little known in England; but it then became known that great ingenuity had been displayed in this art beyond the Atlantic; and also, that the factory system, aided by machinery, was adopted to an extent far a-head of that followed by the lock-makers of England. Stansbury's lock, one of the American inventions, is a modification of the Egyptian lock. Yale's lock bears some resemblance to the Bramah; but it has two concentric cylinders working one within another. Andrews's bank-lock is constructed on the principle of changing the interior mechanism at pleasure, and adapting the moveable bits of the key to suit it, so as to produce a comparatively new lock by every change. Andrews's snail-wheel lock has a series of revolving discs to take the place of tumblers. Newell's lock, like Andrew's bank-lock, has a provision for altering the tumblers and key at pleasure without removing the lock from the door, or essentially altering its mechanism; but this is brought about by the use of two sets of tumblers, the one to receive motion from the other, and having different offices to fill; namely, the key to act upon the first series, and the second series to act upon the bolt. The American *parautoptic* (secret) bank-lock, invented by Mr. Newell when he found that his former lock was not proof against picking, contains a very elaborate series of primary and secondary tumblers, the positions of which are subject to curious changes by the action of the key itself; the owner can change the arrangement of the bits of the key at pleasure; these bits re-arrange the tumblers in the act of locking; and then the lock cannot be opened with the *former* arrangement of bits in the key. This lock obtained a high reputation in America and on the continent; and in 1851 Messrs. Day and Newell took out an English patent for it. Mr. Hobbs afterwards produced his protector-lock, a cheaper and more generally useful variety; it is a modification of the six-tumbler lock, and contains a small piece called a moveable stump, which resists the withdrawal of the bolt until acted upon by the proper key. Another lock by Hobbs has for its object the absolute closing of the key-hole during the process of locking, which is effected in a most curious but complicated manner.

Such are a few of the principal American locks. Long before the date of the Great Exhibition, the makers of those locks maintained an animated controversy respecting the merits of their several inventions, accompanied by challenges and prizes for the picking of the locks. Newell not only picked Andrews's unpickable lock, but picked his own also; and then set about devising new means of security—just as Vauban, having invented a particular system of fortification (his "first"), found out means of capturing fortresses constructed on that system, and then devised another system (his "second") to remedy the defects of the first. When similar lock-picking challenges and controversies took place, at a meeting of the Institute of Civil Engineers in 1850, the American exploits in this art were mentioned; but it was not till the following year that the matter acquired public notoriety. During the Great Exhibition in 1851, Mr. Hobbs made known his opinion that *all* English locks could be picked; he picked one made by Messrs. Chubb, to justify his belief; and then arose a warm controversy as to the question whether the operation was, under all the circumstances, fairly conducted. Messrs. Bramah had for many years had a most complicated lock, for the picking of which a prize of two hundred guineas was offered; Mr. Hobbs undertook this task, asked for thirty days to do it in, succeeded, and obtained the prize. But here again a discussion arose as to the fairness or unfairness of the process. And so it has been in other cases. Mr. Smith picked a Newell lock; but in a way which (it was contended), amounted only to a "ringing of the changes" among a certain number of combinations, and not a real picking. Messrs. Puckeredge and Parnell invented a lock, the picking of which was to be rewarded with a prize; the lock was picked, or at least opened, and the prize claimed; but a court of law decided against the claimant. If it would answer any useful purpose to notice other lock-picking exploits, there are ample materials for doing so; but it is obvious that all the challenges on this subject are likely to be vitiated by various circumstances, and the results contested with angry feelings; for a man whose trade is that of making safety-locks would not be very ready to acknowledge the vulnerability of his own productions. The best result of these contests has been, that all the best locks have been made still better than before, by additional securities suggested by the contests themselves. Mr. Hobbs in 1853, picked a lock in a few minutes which had just won a prize from the Society of Arts—since which event it has been deemed better to let the lock-makers fight their own battles, without any testimonials or sanction from learned bodies. Mr. Denison has devised a lock in which a handle suffices to shoot or lock the bolt, but the unlocking cannot be effected except by the previous use of a very small key—an arrangement which he thinks likely to be useful in giving an employer much control over his clerks and others in the use of the lock.

The usefulness of this series of controversies has also been shown in the improvement of the manufacture of locks generally, both in efficiency and cheapness. Messrs. Hobbs and Ashley have introduced the American plan of manufacturing by machinery, ensuring both rapidity and exactness to a degree not attainable by mere hand-work; and it can hardly be doubted that English manufacturers must ultimately follow the same course. Mr. Price, of Wolverhampton, living in the very centre of the lock-making district, states that down to 1856, there was scarcely a machine of any kind used in the manufacture of locks and keys throughout the whole district. Wolverhampton makes most of the good locks, Willenhall nearly the whole of the common kinds; but in the one place, as in the other, the operations are almost wholly hand-work. The manufacture is mostly in the hands of small masters, each of whom works at the bench himself, and employs a small number of men and apprentices. The produce is sold to the Wolverhampton factors or merchants; and many of the small masters depend on the weekly receipts from the factors for the means of carrying on the next week's operations. There are very few lock-manufactories where the trade is conducted on anything like a large scale.

The principle and detail of modern lock-construction will be found fully treated in Tomlinson's 'Cyclopædia of Arts;' in the 'Rudimentary Treatise,' forming a part of Weale's Series; and in Denison's Essay, reprinted from the new edition of the 'Encyclopædia Britannica;' while Price's bulky volume (nearly 1000 pp.) on safes, locks, and keys, is a storehouse of gossip on all parts of the subject.

LOCKED JAW. [Tetanus.]

LOCUS. This word, or the Greek *τόπος*, signifying simply *place*, was used by the first geometers to denote a line or surface over which a point may travel, so as always to be in a position which satisfies some given condition. Thus, suppose it required to find the position of a point at which a given line subtends a right angle: the answer is, that the number of such points is infinite; for that any point whatsoever upon the surface of a sphere which has the given line for its diameter is such a point as was required to be found. This would be expressed as follows:—the *locus* of the point at which a given line subtends a right angle, is the sphere described on the given line as a diameter. If, however, the point were required to be in a given plane, its locus would no longer be the whole sphere, but only that circle which is the common section of the sphere and the given plane.

The following assertions are really nothing more than common propositions of geometry, stated in such a manner as to introduce the term locus. (1.) The locus of the vertex of an isosceles triangle described upon a given base is the straight line which bisects the base at right angles. (2.) The locus of the vertex of a triangle which has a given base and a given area is a pair of straight lines parallel to, but on different sides of, the base. (3.) The locus of the vertex of a triangle which has a given base and a given vertical angle, and which lies on a given side of the base, is an arc of a circle of which the given base is the chord; and so on.

The geometrical analysis of the Greeks depended much upon the investigation of loci, and the method of using them will sufficiently appear by one instance. Suppose, for example, it is required to describe a triangle of given area and given vertical angle upon a given base. Laying down the given base, it is easy to draw the parallel which is the containing line, or locus, of the vertices of all the triangles which have the given area; and also, upon the same side, the arc of the circle which is the locus of the vertices of all the triangles having the given vertical angle. If then the parallel and the arc of the circle intersect, the point or points of intersection are obviously the vertices of triangles which satisfy all the required conditions; if they do not intersect, the problem is impossible. When the locus of all the points satisfying a given condition cannot be ascertained by elementary geometry, and when this locus is therefore taken for granted, we have the species of solution which was called *mechanical*. An instance of this will appear in the article Trisection of the Angle.

It is to be understood that no curve whatever is called the locus of a point, unless any point whatsoever of that curve may be taken as the point in question. Thus, if each of six points should satisfy certain conditions, all lying upon a given circle, and if no other point of the circle should satisfy those conditions, that circle would not be called the locus of the points.

LODGINGS, in the law of landlord and tenant, is applicable only to apartments let for habitation in the same house with another; and whether the apartments be furnished or no, the law is the same.

The letting, as it comprises an interest in land, should satisfy the 29 Car. II. c. 3 § 4 by being in writing, and must, when produced in court, appear to be signed at least by the party against whom it is produced. Such letting entitles the lodger, without express mention for that purpose in the contract, to the use of all those conveniences which are properly common to the inmates of the same house, and necessary to the comfortable use of his apartments, such as door-knocker, door-bell, water-closet, and the like, the withdrawal of any of which by his landlord may be a ground of action for the lodger.

During the term of occupancy, if any of the lodger's goods are lost or stolen from the house, the landlord is not liable to make good the loss, as an innkeeper would be, unless it appear that he was privy to the wrong. On the other hand, if rent is in arrear to the superior landlord he may distrain on the goods of the lodger found in the house, notwithstanding no rent is due from him to the mesne landlord; the lodger's remedy in that case being against his immediate lessor, by action at law for the value of the goods taken.

The term for which lodgings are let may extend to any period whatever, with this difference however as to the instrument of contract, that it must be by deed if the term exceeds three years by so much as a day. Usually, however, such apartments are let for a portion of a year merely—it may be six months, a quarter of a year, a month, or a week—and the rent, if not a gross sum for the whole period, may be stipulated as payable by the week, month, or other convenient period. If it appear by the contract, taken as a whole, that it was for a period absolutely, the tenancy expires with the end of the time, and there is no necessity for notice to terminate it. But if it appear that both parties to the contract contemplated a continuing tenancy, terminable by either on giving the usual notice, it then becomes a question what notice must be given. It is by no means certain that a weekly tenant is bound, in the absence of usage or contract, to give any notice whatever of his wish to end the tenancy; in London he must give a week's notice, but that depends on the custom. Some text-writers have inferred that monthly, quarterly, or half-yearly tenancies are only terminable by a notice of equal length with the tenancy. No doubt such a notice would be sufficient, and it is the safer course to adopt when convenience will allow. But in the absence of any contract between the parties, it does not appear but that a month's notice, terminating with the end of the period, would suffice to determine a tenancy for any shorter time than a year. Where a person hired furnished apartments for three months, and a receipt was given for the rent payable for the whole period, but at the end of the time he continued still to occupy, it was held that the jury might infer from these circumstances that the tenancy was continued afterwards from week to week.

The 7 & 8 Geo. IV. c. 29, § 45, protects the property of those who let lodgings from the dishonesty of their tenants by making it felony for the person in occupation to steal or appropriate any chattel or fixture allowed to be used in any house or lodging.

On this subject see further Woodfall, *Landlord and Tenant*.

LOG and LOGLINE. The apparatus by which the velocity of a ship's motion through the water is measured. If at any moment a piece of wood, or other light substance, be thrown out of a ship while sailing, as soon as it touches the water it ceases to partake of the ship's motion; the ship goes on, and leaves it behind. If then after a certain interval, say of half a minute, the distance of the vessel from the floating body be accurately measured, the rate of the ship's motion through the water will be ascertained; we do not say the actual rate of the ship's going, but only that of its motion through the water, because in many cases currents exist, and the wood itself is carried along; consequently the true rate cannot thus be known.

This is the principle of the log: in practice the log is a flat piece of wood, generally of the figure of a quadrant, loaded with lead on its arc, to make it float upright; to this is attached a line about 150 fathoms long, divided into equal lengths by little pieces of knotted twine rove into it. These divisions begin about twenty or thirty yards from the log, where a piece of red rag is usually fastened, in order to show the place readily. All the line between the log and the rag is called the stray line, and is of course omitted from the account. When the log is thrown into the sea, which is done from the lee quarter of the vessel, the log-line, by the help of a reel on which it is wound, is immediately veered out, at least as fast as the ship sails; as soon as the red rag leaves the reel, a half-minute glass is turned, and when the sand is all run down, the reel is stopped. Then by measuring the quantity of line run out, the distance sailed by the vessel in half a minute is known, and by calculation its rate of going per hour. There are various ways of dividing the line, the most usual of which is to place the knots at distances of 50 feet from each other; now as 120 times half a minute make an hour, and 120 times 50 feet make almost a geographical mile, so many knots will run from the reel in an experiment as the vessel sails miles in the hour; from this comes the expression of a vessel's sailing so many knots an hour—meaning miles. Fifty-one feet would be more accurately 120th part of a mile than 50 feet; but it is found practically that the ship's way is always a little more than that given by the log, arising from the circumstance that the line is unavoidably pulled in some degree, and the log is consequently not a fixed point; it is moreover safer to have a ship behind the reckoning than before it, which induces many commanders to shorten the distances between the knots to forty-eight and even forty-five feet. Whatever distance be taken, it is found convenient to subdivide into ten parts for decimals of a mile. Careful commanders remeasure the log-line frequently, to ascertain if it varies from its original length. In case of an alteration they apply a correction to the rate found by a common process in the rule of three—as the length which the commander reckons upon is to the real interval, so is the apparent rate to the true rate. A similar correction is required if the half-minute glass is found to be wrong.

In the best regulated vessels the log is hove every hour; and in calculating the ship's going it is supposed that the rate has not varied between the intervals of heaving; but if the wind has sensibly varied, or more or less sail has been set during the time, then an allowance is made according to the discretion of the person who keeps the account.

A few years ago a very curious log was invented by Mr. Hookey, which though ingenious was too complex to come into general use; its object was to afford as great a resistance as possible to the pull of the line, and at the same time to be easily drawn back to the ship when its work was done. This log is shaped like a fish, and the line is in its mouth.

A more practically useful suggestion of Mr. Hookey was to soak the line in a mixture of three parts linseed oil and one part fish oil, which prevented its shrinking; a matter of no small importance when it is considered that a new line without preparation will lose 50 or 60 feet of its length by contraction when wetted.

Of late years Massey's patent log has been used with great benefit to navigation, as the time being noted when it is put overboard, it may be allowed to tow a-stern for hours, at the expiration of which the number of revolutions of a vane attached to it, may be read off from a self-registering dial, and compared with the time, from which is deduced the ship's velocity. Its form is too well known to need further description.

LOG-BOARD and LOG-BOOK. These contain the account of the ship's progress, as deduced from observations of the log. The log-board is either a large piece of plank, blackened, ruled, and prepared for writing on with chalk, or else a slate with divisions scratched upon its surface. As soon as the seaman has hove the log, and the rate of motion is ascertained, the number of knots, with the odd tenths, or odd fathoms, eight of which equal one knot, are written on the board, each in its proper ruled column; also the course of the vessel, the direction of the wind, and any remarks made at the moment. This is repeated every time the log is hove, and once in twenty-four hours the whole is copied into a book called the log-book, which is ruled for the purpose in the same way as the log-board, and in which also all the transactions relative to navigation are inserted, such as bearings and distance of lands, rocks, and shoals, the direction and velocity of currents, the state of the weather, and also whatever principal operations are performed in the ship, such as reefing topsails, tacking, wearing, &c. It is also usual to set down every day the whole course and distance run, calculated from the results of all the several trials made by the log, with the distance and bearing of some port to which the ship is approaching. The account thus obtained is technically termed dead-reckoning, and is never quite correct, being subject to all the errors caused by changing the direction and velocity in the intervals of observing, by the sort of guess usually made at the course and rapidity of currents, and at the amount of the falling off of the vessel from its apparent course, technically called lee-way. The dead reckoning is however necessarily used until an opportunity is afforded of taking observations for latitude and longitude, or until some place whose position is known comes in sight; the true place of the ship is then substituted in the log-book for that obtained by dead reckoning, and from that place subsequent reckonings are made until another observation.

By 17 & 18 Vict. c. 104, the Board of Trade sanction certain forms of log-books (called *official* logs) as adapted to certain kinds of voyages, and it is rendered imperative on every commander to see that all entries therein be made as soon as possible after the occurrences happen which are therein noted.

The official log-book is supposed to contain, in addition to the nautical memoranda above named, a faithful register of every crime and offence, with their punishment, on board the ship; every case of accident or illness, with particulars of treatment; the cause of every death; a register of births; every marriage; the sale of deceased seamen's effects; the character of each of the crew, or sufficient reasons for withholding the opinion thereupon; a full account of all accidents to the ship and stores; details of collisions, &c.: indeed the ship's log-book forms not only a complete history of the voyage, but adds to our knowledge of marine statistics, and thus furthers materially the interests of commerce, while its records promote the ends of justice, for entries in the official log are received as evidence in any court of law

Nor is commerce alone the gainer by attention to the log-book. Remarks on temperature, winds, weather, and indeed all notable diurnal phenomena, have, by indefatigable comparisons and well digested deductions, enlightened the meteorologist; while the hydrographer has enriched with no less zeal the treasures of nautical science from the mere notes of the observant sailor. These would seem to be the only legitimate subjects which claim a navigator's attention in keeping his log-book, but the progress of education among sea-officers is shown year by year in a manner as pleasing as it is important. The zoologist, the natural historian, and indeed the philosopher himself, perceive and acknowledge the vast benefits which a judicious naval observer may yet confer on science. The field for research is a wide one: the heavens, the atmosphere, the ocean, each yields its quota of absorbing interest and improving pastime to the intelligent sailor, and impressions as indelible as they are ennobling lead him insensibly towards social elevation. Little indeed should we know of currents, trade winds, the gulf stream, dust showers, &c., but for the seaman's "log-book," official or private.

LOGARITHMIC CURVE and LOGARITHMIC SPIRAL. The former has for its rectangular equation $y=a^x$, and its most remarkable property is that its subtangent is the same at every point of the curve. The latter has $r=ca^\theta$ for its polar equation, and its tangent always makes the same angle with its radius vector; whence it is called the equiangular spiral.

LOGARITHMS. The etymology of this word is λογῶν ἀριθμός, *the number of the ratios;* and the reason for the appellation will appear in the course of this article. We assume that the reader has the common knowledge of logarithms, and of the method of using them.

We have abandoned the intention of giving a view of the rise and progress of logarithms, for the following reasons. The subject is now one of such wide extent, when its theory and practice are both included, that it would be like writing the history of a complete science to put together all that would be needed in an article professing to show the past and present state of logarithmic algebra, as well as of logarithmic computation. If we were to confine ourselves to the latter only, the view of the subject would be too confined. And since the elements of the subject now usually given are clothed in the most modern algebraical form, it would take considerable space to explain at length the process of the early writers in terms intelligible to those who are not conversant with their writings. We shall therefore devote the first part of this article to such explanations as will enable the student, fresh from modern books of algebra, to read the various histories which exist with facility: and we shall then point out how to deduce the principal formulæ connected with logarithms.

The early history of logarithms will be found at length in the preface to Dr. Hutton's Tables; in the 'History of Logarithms' contained in the first volume of Dr. Hutton's Tracts, in Delambre's 'Histoire de l'Astronomie Moderne,' vol. i. pp. 491–568. See also TABLES, and, in the BIOG. DIV., NAPIER, BRIGGS, GUNTER, KEPLER, MERCATOR, &c.

The idea of logarithms originally arose (in the mind of Napier) from the desire to make addition and subtraction supply the place of multiplication and division. A table, in which are registered 1, a, a^2, a^3, &c., supplies this desideratum to a certain extent; for since a^x multiplied by a^y gives a^{x+y}, we find the product of the first by adding their exponents, and looking in the table for the $(x+y)$th power. Thus for the set 1, 2, 4, 8, 16, &c., a table of logarithms is easily constructed, a specimen of which is as follows:—

Num.	log.	Num.	log.	Num.	log.
1	0	32	5	1024	10
2	1	64	6	2048	11
4	2	128	7	4096	12
8	3	256	8	8192	13
16	4	512	9	16384	14

Thus, to multiply 64 and 128, that is, to find the product of the sixth and seventh powers of 2, we must take the (6+7)th or 13th power, which, from the table, is 8192.

Such a table would be useless for general purposes, since it omits more numbers than it contains. But if we take a very little greater than unity, the powers will increase but slowly, and every whole number within given limits may be made either a power of a, or very near to a power of a. Suppose, for instance, that we wish for a table of logarithms which shall contain among its numbers either every whole number under a million or a fraction within h of every number under a million. Extract the square root of one million, the square root of that square root, and so on, until, say the rth root of one million has been extracted, and let this rth root be $1+t$. It is obvious that this extraction may be carried on until t is small as we please. Consequently $(1+t)^r$ is a million, and every lower power of $1+t$ is less than a million, so that (m standing for a million) no two consecutive powers differ by so much as the difference of m and $m(1+t)$, or by so much as mt. If then we proceed with the extraction until mt be less than h, we shall have t of the degree of smallness required: that is, since every whole number less than m lies between two powers of $1+t$, having exponents less than r, *à fortiori* every such whole number must be within h of some power of $1+t$.

This is in fact the first view which was taken of the method of constructing tables of logarithms; and it must be remembered that Napier was not in possession of the modern way of expressing the powers of quantities. On the methods of facilitating such enormous computations, and on the details which still remained for the first calculators after they had applied all the analysis which they had, we have not here to speak; but we shall now show how the table may be formed by mere labour, and how the word logarithm arises.

Let us suppose that our system is to be such that 0 being the logarithm of 1, a hundred thousand shall be the logarithm of 10. If the hundred-thousandth root of 10 be extracted and called $1+t$, it would be found that 2 is very nearly the 30103rd power of $(1+t)$, that 3 is very nearly the 47712th power of $1+t$, and so on. If then, beginning with 1, we increase it in the ratio of 1 to $1+t$, giving $1+t$; if we increase this in the ratio of 1 to $1+t$, giving $(1+t)^2$, and so on, it appears that we shall reach 2 (or very near to it, one way or other), when 30103 such ratios have been taken; or if we pass from 1 to 10 by 100000 steps, increasing each time in the same ratio, we shall come nearest to 2 in 30103 steps, which is therefore the number of times the increase is made in a certain ratio, or the number of the ratios, the *λογῶν ἀριθμός*, or the logarithm, of 2.

In such a table it must of course follow that the logarithm of a product is exactly or very nearly the sum of the logarithms of the factors, since for instance 2 being $(1+t)^{30103}$ and 3 being $(1+t)^{47712}$ very nearly, 6 must be very nearly $(1+t)^{77815}$. Nor is this property altered, if we divide or multiply all the logarithms by the same number. If then we divide every logarithm by 100000, the logarithm of 10 becomes 1, that of 2 becomes ·30103, and that of 3 becomes ·47712, as in the common tables.

The first step of importance which was made in the logarithmic analysis was the following. If t be very small, the lower powers of $1+t$, the square, cube, &c., are $1+2t$, $1+3t$, &c., very nearly; or if m and n be not so great but that mt and nt are still small, the mth and nth powers of $1+t$ are $1+mt$ and $1+nt$ very nearly. But the logarithms of these powers are m and n; that is, if k and l be small, the logarithms of $1+k$ and $1+l$ are very nearly in the proportion of k to l. If then we take two numbers, a and b, and extract a very high root (say the rth) of both, so that the results are very near to unity, say $1+k$ and $1+l$, we have (nearly)

$$\log. \sqrt[r]{a} : \log. \sqrt[r]{b} :: k : l.$$

But the two first terms are in the same ratio as $\log a : \log. b$, since the multiplication of the former terms by r gives the latter. Consequently, when the logarithm of one number is known, that of any other can be found to any degree of nearness. We shall presently see this in a clearer form; it is sufficient here to show how the theorem was first obtained. If to the preceding methods we add that of INTERPOLATION, which Briggs used with success, we have before us the bases of the original computations of logarithms.

It was evident from the first that the connection between a logarithm and its number must be of the following kind: when the logarithm increases in arithmetical progression, the number must increase in geometrical progression; so that if a and $a+b$ be the logarithms of A and AB, then $a+2b$, $a+3b$, &c., must be the logarithms of AB², AB³, &c. Several mathematicians had formed this conception; but the preliminary difficulty which stopped their progress was their being unable to present the series of natural numbers (or fractions of a high degree of nearness to them), in the shape of terms of a geometrical progression. The great merit of Napier is threefold: first, he distinctly saw that all numbers, within any given limit, may be either terms, or as near as we please to terms, of a geometrical progression; secondly, he had the courage to undertake the enormous labour which was requisite for the purpose; thirdly, he made an anticipation of the principle of the differential calculus in developing the primary consequences of the definition.

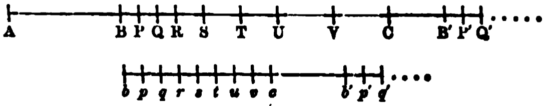
The predecessors of Napier probably did not well understand the notion of a quantity varying in geometrical ratio, while another varied simultaneously, but in an arithmetical ratio. The difficulty is that which a beginner finds in seizing the notion of compound interest carried to its extreme limit, so that every fraction of interest, however small, begins to make interest from the moment it becomes due. We have preferred to omit this consideration in the article INTEREST, where it would have been of no practical use, and to introduce it here, where it may aid in the explanation of the first principles of logarithms.

Let £1 become £$(1+r)$ in a year, and consequently, at the same rate of interest, it becomes £$(1+r)^n$ in n years. Suppose however that interest, instead of being payable yearly, is paid z times in a year, and that interest makes interest from the moment it is paid. Consequently, at the end of the first, second, &c. fractions of a year, the pound first put out becomes

$$1+\frac{r}{z},\ \left(1+\frac{r}{z}\right)^2,\ \left(1+\frac{r}{z}\right)^3\ .\ .\ .$$

or $\left(1+\frac{r}{z}\right)^z$ at the end of one year, and $\left(1+\frac{r}{z}\right)^{nz}$ at the end of n years.

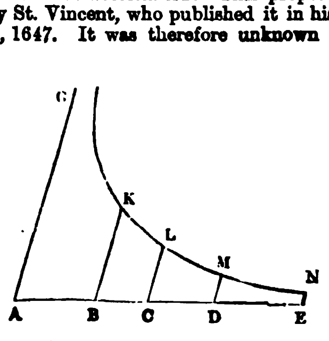
If we may make z as great as we please, that is, if we may make payments of interest follow one another as quickly as we please, we may make the increase of the pound approach as nearly as we please to a gradual increase, of which it must be the characteristic that in successive equal times the amounts are in geometrical progression. Let AB become AC in a time reprepresented by bc. Divide bc into any number of equal parts, and in the successive equal times bp, pq, qr, &c., let a point move through BP, PQ, QR, &c. In the article ACCELERATION is explained the manner in which a succession of impulses, sufficiently small in amount, and often repeated, may be made to give, as nearly as we please, the results of a perfectly gradual motion. At B let a velocity be given sufficient to carry the point to P in the time bp; at P let an impulse be given which would cause PQ to be described in the time pq, and so on. And let AB, AP, AQ, &c., be a continued set of proportionals, namely, AB : AP : : AP : AQ : : AQ : AR, &c. Increase the number of subdivisions of bc without limit, and we approach as a limit to gradual motion of such a kind that the distances of the point from A, at the end of *any* successive equal times, shall be in continued proportion. To show this, suppose we compare the motion from B to C with any other part of the motion described in some subsequent time $b'c'$ (equal to bc), and which carries the moving point from B′ to C′. Divide the time $b'c'$ into as many equal parts, $b'p'$, $p'q'$, &c., as before, and let B′P′, P′Q′, &c., be the lengths described in the second set of subdivisions. Then by the law of the motion AB : AP : : AB′ : AP′, whence BP and B′P′ are in the ratio of AB to AB′; and similarly PQ and P′Q′ are in the ratio of AP to AP′, that is, of AB to AB′; and so on. Consequently, the sum of BP, PQ, &c., or BC is to the sum of B′P′, P′Q′, &c., or B′C′, in the same ratio of AB to AB′; whence also AC is to AC′ as AB to AB′, or AB : AC : : AB′ : AC′. That is, if in any one time the distance from A increases from X to Y, and in any other equal time from X′ to Y′, then X : Y : : X′ : Y′. From which it readily follows that the distances attained at the ends of successive equal times are in continued proportion.



More than this, the velocities of the moving point at B and B′ are as BP to B′P′ (these being spaces described in equal times): and the ratio of these, however many may be the number of subdivisions, is always that of AB to A′B′. Hence a gradual motion of the character described is one in which the velocity of the moving point increases in the same proportion as the distance from A.

In the preceding diagram, the time elapsed from B to C is the logarithm of AC, that of AB being 0. An infinite number of systems may be constructed, depending on the different velocities with which the moving point may be supposed to start from B. In Napier's system, at least in that system stripped of certain peculiarities not worth noting at present [TABLES], AB being a unit, the point starts from B at the rate of a unit of space (AB) in a unit of time: obviously the most simple supposition which can be made, and which has procured for this system the distinctive title of *natural* logarithms. In Briggs's system the point starts from B with such a velocity that (AB being 1) it shall have attained 10 times AB in one unit of time. This requires, as we shall see, an initial velocity of 2·302585 . . . times AB in one unit of time.

In addition to the principles here laid down, a known property of the hyperbola very early showed that logarithms would become applicable to geometry: and thus it happened that the first decidedly algebraical step in the computation of logarithms was announced in Mercator's 'Logarithmotechnia,' as the quadrature of the hyperbola. Let AE and AG be the asymptotes of an hyperbola, and let AB, AC, AD, &c., be in continued geometrical progression. Draw BK, CL, DM, &c., parallel to the other asymptote AG, then the hyperbolic trapezia BKLC, CLMD, DMNE, &c., are equal, or BKLC, BKMD, BKNE, &c., are in arithmetical progression. So that any trapezium BKMD is a logarithm to its terminal abscissa AD. This property was the discovery of Gregory St. Vincent, who published it in his 'Opus Geometricum,' Antwerp, 1647. It was therefore unknown both to Napier and Briggs.



We shall now take the question of logarithms, availing ourselves of the power of modern algebra.

Definition.—By the logarithm of a number let any such function of that number be understood as has the following property. When x is to y as x' is to y', the logarithm of x exceeds or falls short of the logarithm of y by as much as the logarithm of x' exceeds or falls short of that of y'. Let ϕx be the function which a number is of its logarithm: so that $x=\phi\,(\log x)$. If then a and $a+b$ be logarithms of x and y, and if c be the logarithm of x', then as $x:y::x':y'$, $c+b$ must be the logarithm of y'. And x, y, x' and y' are severally $\phi\,a$, $\phi\,(a+b)$, $\phi\,c$ and $\phi\,(c+b)$. But $x\,y'=x'\,y$, or

$$\phi\,a\times\phi\,(c+b)=\phi\,c\times\phi\,(a+b).$$

Let $\phi\,a$ or x be the number which has 0 for its logarithm; then $a=0$; and calling N the number in question, we have

$$\mathrm{N}\times\phi\,(c+b)=\phi\,c\times\phi\,b,$$

$$\text{or } \frac{\phi\,(c+b)}{\mathrm{N}}=\frac{\phi\,c}{\mathrm{N}}\times\frac{\phi\,b}{\mathrm{N}}.$$

But by the theorem proved in the article BINOMIAL THEOREM, this can only be true on the supposition that $\phi\,c\div\mathrm{N}$ is such a function of C as C^c, where C is independent of c. Consequently, the number whose logarithm is c must be $\mathrm{N}\,\mathrm{C}^c$. This evidently satisfies the conditions, and the theorem quoted shows it to be the only function which satisfies the conditions.

It is most convenient to assume 1 as the number N, which has 0 for its logarithm. We have then the following equation, connecting a number with its logarithm,

$$\mathrm{C}^{\log x}=x:$$

so that every number has a logarithm for any value of C we may take, only it must be remembered that the same value of C must always be used. The logarithms of all numbers for a given value of C form a *system*: and C is called the *base* of that system.

Given a system of logarithms, we now inquire how to find the logarithms in any other system. Let A and B be the bases of the systems, and a and b the logarithms of any number x in the two bases. Then we have

$$\mathrm{A}^a=x,\ \mathrm{B}^b=x,\ \text{or } \mathrm{A}^a=\mathrm{B}^b;$$

$$\text{whence } \mathrm{B}=\mathrm{A}^{\frac{a}{b}},\ \text{or } \log \mathrm{B}\ (\text{base } \mathrm{A})=\frac{a}{b},$$

$$b=\frac{a}{\log \mathrm{B}\ (\text{base } \mathrm{A})},\ \text{or } \log x\ (\text{base } \mathrm{B})=\frac{\log x\ (\text{base } \mathrm{A})}{\log \mathrm{B}\ (\text{base } \mathrm{A})};$$

that is, to turn one system of logarithms into another with any new base, divide every logarithm in the system by the logarithm which there belongs to the new base.

We now proceed to the method of determining logarithms. In the article LIMIT it is shown, by means of the binomial theorem, that of the two series

$$1+a+\frac{a^2}{2}+\frac{a^3}{2.3}+\frac{a^4}{2.3.4}+\ldots;$$

$$1+ax+\frac{a^2x^2}{2}+\frac{a^3x^3}{2.3}+\frac{a^4x^4}{2.3.4}+\ldots;$$

the second is the xth power of the first. A remarkably simple case presents itself, which, in fact, leads to Napier's system of logarithms: it is when $a=1$. In this case the first series becomes

$$1+1+\frac{1}{2}+\frac{1}{2.3}+\frac{1}{2.3.4}+\ldots;$$

which is very convergent, and is 2·718281828, very nearly. This remarkable series is generally denoted by ϵ (sometimes by e, Laplace always uses c for it), and we have

$$\epsilon^x=1+x+\frac{x^2}{2}+\frac{x^3}{2.3}+\ldots$$

In Napier's system, then (we shall presently show that this is Napier's system), x is the logarithm of $1+x+\frac{1}{2}x^2+\ldots$; or the logarithm being given, the number can be immediately found.

Since the last equation is universally true, for x write $\log a\times x$, where $\log a$ means $\log a$ (base ϵ). The first side then becomes

$$\epsilon^{\log a\times x},\ \text{or } (\epsilon^{\log a})^x,\ \text{or } a^x;$$

$$a^x=1+\log a.x+\frac{(\log a)^2.x^2}{2}+\ldots\ldots;$$

$$\frac{a^x-1}{x}=\log a+\frac{(\log a)^2.x}{2}+\ldots\ldots$$

if x be diminished without limit, we have then

$$\text{Limit of } \frac{a^x-1}{x}=\log a\ (\text{base } \epsilon);$$

or, for a given (and very small) value of x, the logarithms of different numbers (a) are very nearly in the proportion of the values of a^x-1. This is the theorem to which we have before alluded.

Let $a=1+b$, then

$$(1+b)^x=1+xb+x\frac{x-1}{2}b^2+x\frac{x-1}{2}\frac{x-2}{3}b^3+\ldots$$

$$\frac{(1+b)^x-1}{x}=b+\frac{x-1}{2}b^2+\frac{x-1}{2}\frac{x-2}{3}b^3+\ldots;$$

if x diminish without limit, the limit of the first side has been shown to be $\log(1+b)$, the base being ϵ, which is always to be understood when the contrary is not expressed. The limit of the second side is easily found by making $x=0$, and we thus have

$$\log(1+b)=b-\frac{b^2}{2}+\frac{b^3}{3}-\frac{b^4}{4}+\ldots,$$

which however is only convergent when b lies between -1 and $+1$ Since this last is universally true, we find, by substituting $-b$ for b,

$$\log(1-b)=-b-\frac{b^2}{2}-\frac{b^3}{3}-\frac{b^4}{4}-\ldots;$$

and subtracting the first from the second, remembering that

$$\log(1+b)-\log(1-b)=\log\frac{1+b}{1-b},$$

we find that

$$\log\frac{1+b}{1-b}=2\left\{b+\frac{b^3}{3}+\frac{b^5}{5}+\ldots\ldots\right\}$$

Let $\frac{1+b}{1-b}=x$, or $b=\frac{x-1}{x+1}$;

$$\log x=2\left\{\frac{x-1}{x+1}+\frac{1}{3}\left(\frac{x-1}{x+1}\right)^3+\ldots\right\},$$

which is always convergent, but converges very slowly when x is considerable. If however we make

$$x=\frac{z+1}{z},\ \text{or } \frac{x-1}{x+1}=\frac{1}{2z+1};$$

then, remembering that $\log\frac{z+1}{z}=\log(z+1)-\log z$, we have

$$\log(z+1)=\log z+2\left\{\frac{1}{2z+1}+\frac{1}{3}\frac{1}{(2z+1)^3}+\ldots\right\},$$

which is very convergent when z is even so small as 1, and serves to find the logarithm of any number when that of the next lower number is given. The two following series, which may be easily proved from the preceding, will complete the list of those which are most useful in practice:

$$\log(z+a)=\log z+\frac{a}{z}-\frac{1}{2}\frac{a^2}{z^2}+\frac{1}{3}\frac{a^3}{z^3}-\ldots;$$

$$\log(z+a)=\log z+2\left\{\frac{a}{2z+a}+\frac{1}{3}\left(\frac{a}{2z+a}\right)^3+\ldots\right\}.$$

It only remains to show the identity of this system with that of Napier. If t be the number of seconds elapsed from the beginning of a motion, and if a^t be the length described in that time, then the time is the logarithm of the length described. The *velocity* at the end of t seconds is the differential coefficient of a^t, or $a^t.\log a$, where the logarithm used is that of the preceding algebraical system; this velocity is therefore $\log a$ at starting, or when $t=0$. Now, in Napier's system this velocity is unity, or $a=\epsilon$: that is, the base of Napier's logarithms is the series called ϵ. But in the system whose base is 10, $\log a$ is 2·3025851, which is the velocity at starting assumed by Briggs.

By the foregoing series a system of Naperian logarithms may be calculated with a very small fraction of the labour which they cost their inventor. This having been done for all whole numbers within the given limits, the logarithm of any fraction is readily found by subtracting the logarithm of the denominator from that of the numerator.

It must be admitted that Briggs, by his construction of the decimal system, divides with Napier the merit of inventing logarithms, considered as an instrument of calculation. In the Naperian system the table must either be carried to an enormous length, or whole numbers only must have logarithms, and every logarithm of a fraction will require two entries of the table and a subtraction. But in Briggs's system the logarithm of every decimal fraction can be found by one entry of the table, and one inspection of the fraction.

The peculiarity of this system (the base of which is 10) is as follows: Every number or fraction is either a power of ten, positive or negative, or lies between two powers of ten. The powers of ten are ranged in the following table:—

$$\begin{array}{lll}
\ldots\ldots\ldots\ldots & & \\
10^{-4}=\cdot0001 & 10^0=1 & 10^1=10 \\
10^{-3}=\cdot001 & & 10^2=100 \\
10^{-2}=\cdot01 & & 10^3=1000 \\
10^{-1}=\cdot1 & & 10^4=10000 \\
 & & \ldots\ldots\ldots\ldots
\end{array}$$

From which the following rules may easily be obtained: a number which has m figures before the unit's place lies between 10^{m-1} and 10^{m}, and its logarithm therefore lies between $m-1$ and m, or it is $m-1+$ a fraction less than unity. Also, if a fraction be less than unity, and if its first significant figure lie in the nth decimal place, this fraction lies between 10^{-n} and $10^{-(n-1)}$; so that its logarithm is $-n+$ a fraction less than unity. Now the convenience of Briggs's system lies in this, that the fraction less than unity, which is a part of every logarithm, does not depend on the position of the decimal point, but entirely upon the significant figures: the reason being, that an alteration of the position of the decimal point being a multiplication or division by some whole power of 10, alters the logarithm by the addition or subtraction of a whole number. This question is discussed in every treatise on the mode of using logarithms.

Let a be the base of a system of logarithms, and let $\log x$ signify simply the Naperian or natural logarithm of x; then by the theorem already proved

$$\log\,(\text{base } a) = \frac{\log x}{\log a} = \frac{1}{\log a}\cdot\log x.$$

The factor $1 \div \log a$, which converts Naperian logarithms into those whose base is a, is called the *modulus* of the system whose base is a. In Briggs's system this modulus is ·4342945 nearly, and the logarithms of this system being called *common* or *tabular* logarithms, we have—

$$\begin{aligned}\text{common } \log x &= {\cdot}4342945 \times \text{Nap. } \log x\\ &= \frac{43}{99}\times \text{Nap. } \log x, \text{ very nearly.}\\ \text{Nap. } \log x &= 2{\cdot}3025851 \times \text{com. } \log x,\\ &= \left(\frac{100-1}{43} + \frac{1}{4000}\right) \times \text{com. } \log x.\end{aligned}$$

LOGARITHMS, GAUSS'S. These are tables suggested by the celebrated Gauss for supplying an inconvenience connected with the use of logarithms described in § 21 of the article LOGARITHMS, USE OF. Though they have been suggested more than fifty years, they are only beginning to receive the attention which they merit.

If $\log a$ and $\log b$ be given, and $\log (a+b)$ or $\log (a-b)$ be wanted, the ordinary tables can only be applied by finding a and b from their logarithms, adding or subtracting them as found, and then finding the logarithm of the sum or difference. This requires three uses of the tables, and one process of addition or subtraction. Gauss's table substitutes one use of a table, and two processes of addition or subtraction. When the above necessity occurs only now and then, it may be hardly worth while to have recourse to such a table; but in any series of calculations in which the determination of $\log (a \pm b)$ from $\log a$ and $\log b$ is a frequent constituent part, the table is a very great relief.

The construction of the table is as follows: There are three columns styled A, B, C; the first, A, containing the *arguments*. [TABLE.] Also B and C are furnished with differences and tables of proportional parts, in the same manner as the seven-figure logarithms. In column A are entered successive decimal fractions, in a manner depending upon the extent of the table. In the one we shall mention, A contains ·0000, ·0001, ·0002, &c., up to 2·0000; then 2·001, 2·002, &c., up to 3·000; then 3·01, 3·02, &c., up to 4·00; then 4·1, 4·2, &c., up to 5·0, followed by 6 and 7. And whatever an A may be the logarithm of, say N, then its B is the logarithm of $1+\frac{1}{\text{N}}$, and its C is the logarithm of $1+\text{N}$. Thus, opposite to 2·00 in A, which is the logarithm of 100, the B is log 1·01, the C is log 101; accordingly in one part of the table we see

A	B	C
2·00	·0043214	2·0043214

Again, in another part of the table we see

A	B	C
·4845	·1031058	·6076058

And it will be found that ·4845 being the logarithm of N (not mentioned; it is 3·041406), ·1031058 is the logarithm of $1 + 1 \div \text{N}$, and ·6076058 of $1+\text{N}$.

The manner of using this table is as follows: Let x and y be two numbers, of which x is the greater, and let $\log x$ and $\log y$ be given. Then

1. To find $\log (x+y)$. Let $\text{A} = \log x - \log y$
   $\log (x+y) = \log x + \text{B} = \log y + \text{C}$
2. To find $\log (x-y)$. Let $\text{B} = \log x - \log y$
   $\log (x-y) = \log y - \text{A} = \log x - \text{C}$
   Or thus: Let $\log x - \log y = \text{C}$
   $\log (x-y) = \log y + \text{A} = \log x - \text{B}.$

It seems as if this were two tables, each of which might serve all purposes. And it is true that $\log (x+y)$ can always be found from either table. But the B table begins from ·3010300 or log 2, and *descends*, while the C table begins from the same, and *ascends*. Consequently, ·23, for instance, cannot be found about the C's, nor ·32 among the B.'s. So that in finding $\log (x-y)$, $\log x - \log y$ must not be made B if it be greater than log 2, nor C if it be less.

For a list of tables published in aid of the above method, see TABLES.

LOGARITHMS, HYPERBOLIC. As tables of hyperbolic logarithms are not very frequently met with, the following table is given to facilitate the finding of the hyperbolic logarithm by means of the common one. It is in fact a table of the hyperbolic logarithms of the powers of 10: thus opposite to 12 we see 27·63102112, which is the hyperbolic logarithm of 10^{12}, or a million of millions.

To find the hyperbolic logarithm of a number, multiply the common logarithm of that number by 2·30258509, by means of the table. Set down the number opposite to the integer of the logarithm, then that opposite to the first pair of decimal figures, leaving out the two last figures, then that opposite to the second pair, leaving out the four last figures, and so on. Add the results together. But if the characteristic of the common logarithm be negative, subtract the united results of the pairs of decimal places from the result of the characteristic, and make the answer negative. For example, required the hyperbolic logarithms of 327 and of ·00142. The common logarithm of 327 is 2·5145478.

2	4·60517019
51	1·17431839
45	1036163
47	10822
80	184
Hyp. log. 327	5·78996027

The answer can be depended on to about a unit in the seventh decimal place, and 5·7899602 is the answer to seven places.

Again, the common logarithm of ·00142 is $\bar{3}{\cdot}1522883$

—3·	—6·90775528	
15	34538776	Subtract.
22	506568	
88	20262	
30	69	
	—6·55709853	

Hence the hyperbolic logarithm of ·00142 is —6·5570985.

1	2·30258509	34	78·28789316	67	154·27320123
2	4·60517019	35	80·59047826	68	156·57578632
3	6·90775528	36	82·89306335	69	158·87837142
4	9·21034037	37	85·19564844	70	161·18095651
5	11·51292547	38	87·49823353	71	163·48354160
6	13·81551056	39	89·80081863	72	165·78612670
7	16·11809565	40	92·10340372	73	168·08871179
8	18·42068074	41	94·40598881	74	170·39129688
9	20·72326584	42	96·70857391	75	172·69388198
10	23·02585093	43	99·01115900	76	174·99646707
11	25·32843602	44	101·31374409	77	177·29905216
12	27·63102112	45	103·61632919	78	179·60163725
13	29·93360621	46	105·91891428	79	181·90422235
14	32·23619130	47	108·22149937	80	184·20680744
15	34·53877640	48	110·52408446	81	186·50939253
16	36·84136149	49	112·82666956	82	188·81197763
17	39·14394658	50	115·12925465	83	191·11456272
18	41·44653167	51	117·43183974	84	193·41714781
19	43·74911677	52	119·73442484	85	195·71973291
20	46·05170186	53	122·03700993	86	198·02231800
21	48·35428695	54	124·33959502	87	200·32490309
22	50·65687205	55	126·64218012	88	202·62748818
23	52·95945714	56	128·94476521	89	204·93007328
24	55·26204223	57	131·24735030	90	207·23265837
25	57·56462733	58	133·54993539	91	209·53524346
26	59·86721242	59	135·85252049	92	211·83782856
27	62·16979751	60	138·15510558	93	214·14041365
28	64·47238260	61	140·45769067	94	216·44299874
29	66·77496770	62	142·76027577	95	218·74558384
30	69·07755279	63	145·06286086	96	221·04816893
31	71·38013788	64	147·36544595	97	223·35075402
32	73·68272298	65	149·66803105	98	225·65333911
33	75·98530807	66	151·97061614	99	227·95592421

LOGARITHMS, USE OF. We have thought it advisable to add to this work directions on the method of using logarithms, independent of all considerations connected with the meaning and theory of these numbers. Thus a person who has a table of logarithms, and finds its preliminary explanations not sufficiently clear or complete, may possibly receive help from this article, which is not written to accompany any system of tables in particular. There are many reasons against our inserting the table of logarithms itself in a large work of reference, as was frequently done a century ago: we are pretty certain that it would not be used.

1. The object of logarithms is the performance of the second and

third operations in the following ascending scales by means of the more easy one which precedes it, aided by consultation of tables:—

Addition,	**Multiplication,**	**Raising of Powers.**
Subtraction,	**Division,**	**Extraction of Roots.**

Thus multiplication is reduced to addition, raising of powers to multiplication, division to subtraction, extraction of roots to division.

2. The sum of the logarithms of two numbers gives the logarithm of their product, the difference of two logarithms gives the logarithm of the quotient, and so on. These rules are best expressed in symbols, thus:

$$\log \text{A} + \log \text{B} = \log (\text{A} \times \text{B})$$

$$\log \text{A} - \log \text{B} = \log \left(\text{A} \div \text{B} \text{ or } \frac{\text{A}}{\text{B}}\right)$$

$$\log (\text{A}^m) \quad = m \times \log \text{A}$$

$$\log (\sqrt[m]{\text{A}}) \quad = \log \text{A} \div m.$$

3. The logarithms wanted are taken partly from a table, partly from an easily remembered rule. The integer part of the logarithm is found by the rule; the fractional part by the table.

4. The integer portion of the logarithm is called the *characteristic* of the number: thus 2167·3 has 3·33592 for its logarithm, and 3 is the characteristic of 2167·3. It is very common to call this 3 the characteristic of the logarithm itself; but it is better to fix this appellation upon it in connection with the number from which it arises.

5. The characteristic of a number depends entirely upon the place which the decimal point occupies. But the rest, or fractional part, of the logarithm of that number depends upon the significant figures only of the number, and has no connection with the meaning which those figures gain by their position relatively to the decimal point. Thus ·21673, 21·673, ·00021673, 21673, 21673000, &c., are numbers with different characteristics, or different integer portions in their logarithms. But the fractional portions are the same in the logarithms of all, namely, ·33592.

6. The characteristic of a number may be either *positive* or *negative*. For our present purpose, it will be sufficient to lay down the rules for using these quantities, directing the reader who is not used to the distinction to try to explain them by considering positive quantities as gains, negative quantities as losses, addition as junction, subtraction as removal. Thus the addition of a positive quantity (annexation of a gain) is the same thing as the subtraction of a negative quantity (removal of a loss); and so on. The following examples will illustrate this; the negative quantity being distinguished from the positive one by a bar drawn above it:—

8 and $\bar{5}$ make 3.
8 and $\overline{11}$ „ $\bar{3}$.
2 and $\bar{7}$ „ $\bar{9}$.
4 times $\bar{6}$ is $\overline{24}$;
if we carry 3, it gives $\overline{21}$.

$\bar{2}$ from $\bar{3}$ gives $\bar{1}$.
2 from 3 . . . . 5.
3 from $\bar{2}$ . . . . $\bar{5}$.
$\bar{3}$ from $\bar{2}$ . . . . 1.
$\bar{8}$ from $\bar{3}$ . . . . 5.

7. The rule for finding the characteristic is as follows. When there are significant figures before the decimal point, the characteristic is one less than the number of them. But when the significant figures begin after the decimal point, the characteristic must be marked negative, and must point out *the place in which significance begins.* Thus the characteristic of 2791·68 is 3; that of 17462 is 4; that of 29·137 is 1; that of 9·999 is 0; that of ·763 is $\bar{1}$; that of ·0198 is $\bar{2}$; that of ·000072 is $\bar{5}$.

8. It is worth while to remark that this broken rule, as it seems to be, requires subdivision only on account of the notions generally attached to the *decimal point*, which is treated as if it were one of the places of the number. But if the decimal point were, as it ought to be, considered as part and parcel of the *unit's place*, so that 12·34, for instance, is not | 1 | 2 | · | 3 | 4 |, but | 1 | 2· | 3 | 4 |, then the two rules might be given under one, as follows. The characteristic of a number is the number of places by which the first significant figure is distant from the unit's place; and is positive when that first figure falls to the left, negative when to the right. Thus in 1234·567 or 123 (4·) 567 it is 3; in ·00029 or (0·) 00029 it is $\bar{4}$.

9. A mixed number, such as $\bar{3}$· 92741, is thus multiplied and divided:

$$\begin{array}{r} \bar{3}\cdot\ 92741 \\ 6 \\ \hline \overline{13}\cdot\ 56446 \end{array} \qquad\qquad 6)\underline{\bar{3}\cdot\ 92741} \atop \bar{1}\cdot\ 65457$$

In multiplication, the multiplication of the negative figure produces a negative result, and the carriage from the positive part goes in diminution of this number. The last step is: 6 times $\bar{3}$ is $\overline{18}$, and 5 is $\overline{13}$. In division, a divisible figure must be sought *above* the negative characteristic, not *below* it; and the units necessary to make up that divisible figure must be afterwards carried to the right in the usual way. Thus when $\overline{21}$·116 is divided by 5, the first step is: 5 is contained in $\overline{25}$, $\bar{5}$ times, carry 4; then 5 is contained in 41, 8 times, &c.

$$5)\underline{\overline{21}\cdot 116} \atop \bar{5}\cdot 823\,. \qquad 11)\underline{\bar{8}\cdot 212} \atop \bar{1}\cdot 292 \qquad 10)\underline{\overline{31}\cdot 606} \atop \bar{4}\cdot 961$$

10. The decimal part of the logarithm is taken out of the tables. These are not complete logarithms, which could not be given, since the real logarithms are generally interminable decimals. The only numbers which have logarithms capable of finite expression (in the system commonly used) are those in the series . . . . ·0001, ·001, ·01, ·1, 1, 10, 100, 1000, ... of which the complete logarithms are the characteristics themselves, or . . . . $\bar{4}$, $\bar{3}$, $\bar{2}$, $\bar{1}$, 0, 1, 2, 3, ... The tables give only a certain number of the first decimal places, and may be named after the number of decimals in the logarithms they give. Thus a table which gives four decimals in each logarithm may be called a four-figure table; and so on. A calculator chooses his table according to the degree of accuracy he wants: the general rule being that, so many decimals as there are in the logarithms, so many significant figures of the answer may be found correct, with perhaps an error of a unit or two in the last figure. Thus if the real answer to a question were ·00123769728, we might expect from four-figure tables to get ·001236, ·001237, ·001238, or ·001239. But seven-figure tables would probable give from ·001237695 to ·001237699. Perhaps the liability of the last figure to error is, for the general run of questions, rather over than under stated in the above. Four figures are very often enough; five figures almost always. When five figures are not sufficient, we should recommend having recourse to seven at once, for a reason presently mentioned.

11. We insert specimens of a four-figure, five-figure, and a seven-figure table.

FOUR-FIGURE TABLE.

		0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
	..	..	..	..	..	..	..	..	..	..	..	.	.	.	.	.	.	.	.	.
Logarithms.	40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
	41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
	42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7.	8	9
	43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
	..	..	..	..	..	..	..	..	..	..	..	.	.	.	.	.	.	.	.	.
		0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
	..	..	..	..	..	..	..	..	..	..	..	.	.	.	.	.	.	.	.	.
Antilogarithms.	·60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	2	3	4	5	6	6	7	8
	·61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
	·62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	2	3	4	5	6	7	8	9
	·63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9

FIVE-FIGURE TABLE.

Num.	Log.	D.		Num.	Log.	D.
..	..	.		..	..	.
1120	·04922	39		5832	·76582	7
1121	·04961	38		5833	·76589	8
1122	·04999	39		5834	·76597	7
1123	·05038			5835	·76604	
..	..	.		..	..	.

SEVEN-FIGURE TABLE.

No.	0	1	2	3	4	5	6	7	8	9	Pro. P. 95.
4550	6580114	0209	0305	0400	0496	0591	0687	0782	0877	0973	1 10 2 19 3 29 4 38 5 48 6 57 7 67 8 76 9 86
4551	1068	1164	1259	1355	1450	1545	1641	1736	1832	1927	
4552	2023	2118	2213	2309	2404	2500	2595	2690	2786	2881	
....	....	....	....	....	....	....	....	....	....	....	
4559	8696	8791	8886	8982	9077	9172	9267	9363	9458	9553	
4560	9648	9744	9839	9934	0029	0125	0220	0315	0410	0506	
4561	6590601	0696	0791	0886	0982	1077	1172	1267	1362	1458	

12. To find the logarithms of numbers and the numbers to logarithms, from the four-figure table, proceed as follows: From inspection of the number, take the proper characteristic, and then note the first four *significant* figures. In the row which begins with the *first two*, find the figures which are in the column headed by the *third;* and add to them the figures out of the side table which are in the column headed by the *fourth*. For instance, required, as well as it can be given from a four-figure table, the logarithm of 4275898·116. The characteristic is 6: and the first four significants are 4276 (reading 58 rather as 60 than as 50). In the row 42, and under 7, we see 6304, and in the side table opposite to 6 is 6, and 6304 + 6 is 6310. Hence 6·6310 is the logarithm of 4275898·116, so far as the four-figure table will give it. Similarly the logarithm of ·4 (which must be read ·400) is $\bar{1}$·6021, that of 430 is 2·6335, that of ·04179 is $\bar{2}$·6210.

To find the number to a logarithm, *in the four-figure table*, use the *decimals* of the logarithm with the antilogarithmic table in the same manner as the four significants of the number were used in the other table to find the logarithm; and then settle the place of the decimal point by means of the *integer* of the logarithm. The four-figure table goes into so small a space that it is worth while to print an inverse table of *antilogarithms*, or of numbers to logarithms; of which table we have also given a specimen above. Thus the number to the logarithm 5·6234 being required, we neglect 5, and, going into the antitable with ·6234, opposite to ·62 and under 3 we find 4198, and under 4 in the side table we find 4. Hence 4198 + 4 or 4202 are the first four significants of the number required; and its characteristic is 5: whence 420200 is the number to the logarithm, as near as the four-figure table will give it. Similarly the number to ·6111 is 4·084, that to $\bar{3}$·6208 is ·004177, that to 9·6000 is 3981000000.

13. We give an instance of the application of each of the rules in § 2. Let it be required to find, as nearly as four-figure tables will do it, the product of 17798 and 63426; the quotient of 17·293 divided by ·942942; the eighth power of 1·9273, and the eleventh root of ·00005569181. The processes are as follows:—

	Log of 17798 (say 17800)	4·2504	Add.
	Log of 63426 (say 63430)	4·8023	
	Log of product	9·0527	
Answer	1129000000 from the table.		
True Answer	1128855948		
Error	144052, about ·0001 of the whole.		

Again, log 17·293 (say 17·29)	1·2877	Subtract.
log ·942942 (·9429)	$\bar{1}$·9745	
Log of quotient	1·2632	
Answer 18·33.		

Log 1·9273 (say 1·927)	0·2849
Multiply by	8
Log of $(1·927)^8$	2·2792
Answer 190·2.	

In raising powers, the errors are generally larger than in other processes, seeing that the necessary error of the logarithm is multiplied as many times as the logarithm itself.

Log ·00005569181 (say ·00005569)	$\bar{5}$·7458
Divide by 11	$\bar{1}$·6133, log $\sqrt[11]{·00005569}$
Answer ·4105.	

14. Before beginning to use five-figure tables, it is advisable to practise the formation of the tenths of numbers not exceeding 50, in the head. For instance, which is the nearest integer to 7-tenths of 37. The process at length would of course be

$$\begin{array}{r} 37 \\ 7 \\ \hline 10)259 \\ \hline 25·9 \end{array} \quad \text{Nearest integer 26.}$$

It should be done thus: Having multiplied 7 by 7, and got 49, reject the units, and carry 5 as the *nearest* number of tens. Then add 5 to 21 obtained from the three. When 5 units are thrown away, consider the ten next above as the nearest. Thus 9-tenths of 45 should be considered as 41, not 40, and 5-tenths of 17 as 9, not 8. Similarly, 8-tenths of 21 is 17; 3-tenths of 19 is 6. But 2-tenths of 32 is 6; 7-tenths of 42 is 29; 9-tenths of 28 is 25.

15. In the specimen of the five-figure table will be seen four figures of number, followed by five figures of logarithms, and an additional column marked D, which contains nothing but the differences between the successive sets of five figures in the logarithm. This column D is referred to under the name of the column of *tabular differences*. To take the logarithm of a number, take the characteristic as before, and five significants of the number. Find out the first four significants in the table, and to their five figures of logarithm *add* as many tenths of the tabular difference as there are units in the fifth significant. Thus to find the logarithm of ·011217, we find 1121 in the specimen, opposite to which is 04961, with 38 for a tabular difference. Now 7-tenths of 38 is 27, and 61 and 27 is 88; so ·04988 is the decimal part of the logarithm. Similarly if the significants of the number be 11223, the decimals of the logarithm are ·05011; also 11201 gives ·04926; 11209 gives ·04957; 58332 gives ·76591; 58333 also gives ·76591; 58334 gives ·76592; and so on.

16. There is no antilogarithmic table to a five-figure table; and the way of finding the number to a logarithm is as follows: Seek out among the logarithms the decimals *next under* the decimals of the given logarithm, and take the four figures of number belonging to them for the first four significants of the number. Find by how much the decimals just used fall short of the given decimals, and call this difference the *unattained part*. Annex a cipher to the unattained part, and divide by the tabular difference; the digit which most nearly expresses the quotient is the fifth significant of the number. For instance, what is the number to the logarithm $\bar{3}$·05016. Looking into the table, we find that the next under ·05016 is 04999, opposite to 1122. The unattained part is 17; the tabular difference 39; and 170 contains 39 4 times more nearly than 5 times; so that 4 is the fifth figure. The five significants of the number required are then 11224; and, looking at the integer part of the logarithm, the characteristic is seen to be $\bar{3}$; whence ·0011224 is the number to the logarithm, as correctly as five-figure tables will give it.

17. The four questions worked above with four-figure logarithms are thus worked with five-figure logarithms:—

17798	4·25037
63426	4·80227
1128900000	9·05264
	05231
	38)330
1·9273	0·28495
	8
190·37	2·27960
	27944
	23)160

17·293	1·23787
·94294	$\bar{1}$·97449
18·339	1·26338
	26316
	24)220
·000055692,	11)$\bar{5}$·74580
·41044	$\bar{1}$·61325
	61321
	10)40

18. The seven-figure tables have five figures of number, with seven decimals of logarithm; and the sixth and seventh significants of the number are to be provided for by means of the tabular differences. But as these tabular differences run to three and four places of figures, their tenths are written down in small separate tables. [PROPORTIONAL PARTS.] To take out a logarithm, take out the seven decimals belonging to the first five significants of the number, and add from the table of proportional parts the number opposite to the sixth significant, and one-tenth of that opposite to the seventh significant. Thus, to find the logarithm of 455173689, of which the first seven significants are 4551737, look in the table for 45517, and we have

45517	. .	gives	6581736
Tab. Pro. P.	3	„	29
„ „	7	„	7
			6581772

So the logarithm required, as far as seven-figure tables will give it, is 8·6581772.

A little practice will enable the calculator to add together, without writing them down, the two contingents derived from the table of proportional parts. The computer must be careful not to miss the change of the third figure of a logarithm, which usually takes place in the middle of a line, though it can only be marked at the beginning. Thus, in the specimen the logarithm of 45603 has the decimals 6589934, but that of 45604 has 6590029, not 6580029. Some mark is usually made to give warning that the change has taken place; but those whose attention is so little alive to the circumstance as to stand much in need of this mark will often make the mistake in spite of it.

19. To take the number to a given logarithm out of seven-figure tables proceed as follows: Find the nearest decimals under the given decimals, and by subtraction find the *unattained part*. Take out the five number-figures belonging to the attained part, for the first five significants of the number. Look in the table of proportional parts for the nearest under the unattained part, and take the digit opposite to it for the sixth significant. Annex a cipher to the remainder of the unattained part, and take the digit opposite to the result (or its nearest) in the table of proportional parts for the seventh significant. For instance, required the number to the logarithm 1·6590176:

$$\begin{array}{rr} & 6590176 \\ 45605\ .\ . & 6590125 \\ \hline & 51 \\ 5 & 48 \\ \hline 3 & 30 \end{array}$$

Number required 45·60553.

20. The following is the working of the four questions already worked with four-figure and five-figure tables:

$$\begin{array}{rr} 17798 & 4·2503712 \\ 63426 & 4·8022673 \\ \hline & 9·0526385 \\ 11288 & 0526170 \\ & 215 \\ 5 & 198 \\ 6 & 220 \end{array}$$

Answer 1128856000.

$$\begin{array}{rr} 17·923 & 1·2378703 \\ ·942942 & \bar{1}·9744850 \\ \hline 18·33941 & 1·2633853 \end{array}$$

$$\begin{array}{rr} 1·9273 & 0·2849493 \\ & 3 \\ \hline 190·3682 & 2·2795944 \end{array}$$

$$\begin{array}{rr} 00005569181 & 11)\bar{5}·7457913 \\ \hline ·4104439 & \bar{1}·6132538 \end{array}$$

21. More complicated questions may be *directly* solved by logarithms, that is, without requiring to seek the number to a logarithm until the end of the process, so long as the multiplications, divisions, involutions, and evolutions are not broken by additions or subtractions. Thus to calculate $\sqrt[11]{\left\{a^2 b \sqrt[3]{c} \div d\right\}}$ we form for the logarithm of the answer

$$\frac{1}{11}\left\{2 \log a + \log b + \tfrac{1}{3} \log c - \log d\right\}$$

But if additions or subtractions intervene, the process must be broken to produce the result; that is, the logarithmic process must be suspended, and the results exhibited in numbers for the performance of the additions and subtractions (unless indeed Gauss's logarithms be employed). [LOGARITHMS, GAUSS'S.] Thus to find $\sqrt{(a^2 b + cd)}$, it would be necessary, not merely to form the logarithms of $a^2 b$ and cd, or $2 \log a + \log b$ and $\log c + \log d$, but to find the numbers to them: these numbers being then added, and the logarithm of the sum being taken, half the last logarithm is the logarithm of the answer.

22. There is nothing in the trigonometrical logarithms more than is described in TRIGONOMETRICAL TABLES. Many young students, from seldom or never using the actual sines, cosines, &c., of angles, but only their logarithms, are apt to confound the former with the latter.

23. Some little additional correctness may be obtained by annexing to the use of the tables, as given above, an attempt to add something for one more figure of the number. Thus, suppose it required to find the logarithm of 11·374928. In the four-figure table 113 has 0531 and ... 7 adds 26. The next figure is 4, which, had it been the fourth significant, would have added 15; being the fifth, let it add the tenth of 15, or its nearest integer, 2. Hence we add 28 instead of 26 to 0531, and get 0559 instead of 0557, as a nearer approach to the logarithm. Again, in the five-figure table, 1137 gives 05576, and the tabular difference is 38. The 4 gives 15, or 4-tenths of 38, and the 9 ought to give 9-hundredths of 38, or 3. Consequently 15 + 3, or 18, is added, giving 05594. Had 49 been read as 50, in the usual way, 19 would have been added. In the seven-figure tables 11374 gives 0559132; 9 adds 345, the 2 should add the tenth of 77, and the 8 should add the hundredth of 306: hence 3 more should be added than arises from the figures 92. This plan may be followed when the greatest accuracy is desirable, especially in the four-figure table. It is most useful when the tabular differences are large, that is, at the beginning of the table.

24. It may sometimes save a mistake if the computer remember that the significants of the number generally read less than those of the decimals in the logarithm. Thus 200 .... has 301 .... for the decimal figures of the logarithm. It is not so however at the beginning of the table, and the figures of the logarithm overtake those of the number between 13712 and 13713.

25. The rule of the characteristics, when well learnt, furnishes one of the easiest modes of assigning the place of a decimal point in a common division. For example, in dividing ·0017643 by ·018416, the characteristics being $\bar{3}$ and $\bar{2}$, we shall have to carry 1 to $\bar{2}$, because significants of the divisor, 18, are greater than those of the dividend, 17. Take $\bar{1}$ then from $\bar{3}$, which leaves $\bar{2}$, the characteristic of the quotient, which has therefore ·0 before its significants. The rule is, to find the characteristic of the quotient, from that of the dividend subtract that of the divisor, carrying 1 if the first significants of the divisor be greater than those of the dividend.

26. In using the trigonometrical tables, or any other, careful attention must be paid to the right choice of the method of interpolation. If the argument and tabular result [TABLE], or the numbers with which we enter the table and those which we take from it, increase together or diminish together, then the alterations introduced by the table of proportional parts consist in adding to either for every addition to the other, and subtracting for every subtraction. But if the tabular result diminish as the argument increases, then every addition to the one is accompanied by a subtraction from the other, and *vice versâ*. In the tables of logarithmic cosines and cotangents, the young computer frequently falls into error from neglect of the last-mentioned direction. Thus the logarithm of the cosine of 84° 9′ in a five-figure table is 9·00828, and the tabular difference is 124, diminishing. Hence the log cosine of 84° 9′·5 is not 9·00828 + ·00062, but 9·00828 − ·00062. And if we ask for the angle whose log cosine is 9·00840, we find the next underneath this in the table to be 9·00828, and 22 for the unattained part. Divide 220 by 124, and 2 is the nearest integer. But the angle required is not 84° 9′ + 0′·2, but 84° 9′ − 0′·2, or 84° 8′·8.

27. The equation $a^x = b$, in which x is unknown, is solved by taking the logarithm of both sides, which gives $x \log a = \log b$, or $x = \log b \div \log a$. The process may perplex a beginner when the logarithms have negative integers. We therefore subjoin an example. Let it be required to solve the equations

$$\left(\frac{4}{7}\right)^x = ·00163 \text{ and } 182^y = ·6.$$

(The reader is supposed to know the complete interpretation of algebraical exponents.) We have then

$$x = \log(·00163) \div \log\left(\frac{4}{7}\right) = \bar{3}·21219 \div \bar{1}·75696$$
$$y = \log\ ·6 \div \log 182 = \bar{1}·77815 \div 2·26007.$$

Now throw the three logarithms which have negative integers into the more usual algebraical forms.

$$\begin{array}{lccc} & ·21219 - 3\ , & ·75696 - 1\ , & ·77815 - 1 \\ \text{Or} & -2·78781\ , & -·24304\ , & -·22185 \end{array}$$

And make the divisions, which give for the quotients 11·471, and −·098161; or

$$\left(\frac{4}{7}\right)^{11·471} = ·00163\ , \qquad (182)^{-·098161} = ·6$$

LOGIC. Since the 'Penny Cyclopædia' was completed, the study of logic in this country has undergone three important changes. First, much more attention is paid to the subject: secondly, innovations have been listened to in a spirit which seems to admit that Kant's dictum about the perfection of the Aristotelian logic may possibly be false: thirdly, a disposition has arisen to distinguish logic from metaphysics and psychology, without losing sight of the psychological and metaphysical discussion which is necessary to a sound view of the meaning, province, and first principles of the science. In such a state of transition the best thing to be done is to allow the main logical articles of the 'Penny Cyclopædia' to stand unaltered, as representatives of a starting point, and to devote the present article chiefly to some account of recent developments and current disputes. We therefore refer to ORGANON, SYLLOGISM, &c., as preparatory to the present article.

We also explain that we are not writing for (nor against) the competent disputant, but for the learner who has mastered the common elements: that we refer to England (meaning the three kingdoms) and English thought only; and that we treat of that part of logic which may be styled an exact science, without any discussion of the grounds on which its obvious postulates are founded.

The changes to which we have alluded arise from that revival of the taste for philosophy which has commenced and is continuing, both in England and France. So far as England is concerned this revival was preceded by the publication of Dr. Whately's work, the first edition of which was an article in the Encyclopædia Metropolitana (about 1826). The author had for years taught the subject at Oxford, and had trained some, at least, to see the low state into which logic had fallen; a state not exaggerated in the unfriendly criticism presently mentioned. This work placed logic, in a comparatively attractive form, within the reach of many out of Oxford, to whom all the attainable books had been sealed by the stamp of a current prejudice; and it had merits of its own. The Archbishop of Dublin possesses the talent which distinguished Paley from his predecessors; the talent of rendering a dry subject attractive in a sound form by style, illustration, and clearness combined. And to him is due the title of the restorer of logical study in England.

In 1836, ten years after the publication of Dr. Whately's work, Sir William Hamilton [BIOG. DIV.] was appointed professor of logic and metaphysics in the University of Edinburgh. The extraordinary character of his learning is not overrated in the article cited. But it should be added, as necessary to be known by any one who enters on the logical controversies of the day, that his strange hatred of the mathematical sciences was owing to an unusual inaptitude for them, which prevented, probably any sufficient study, certainly any real understanding, even of their lowest branches. In 1829, he commenced that powerful series of articles in the 'Edinburgh Review' by which his reputation was first established out of Edinburgh: these were republished with some additional notes, under the title of 'Discussions in Philosophy;' and no higher logical student can dispense with them. In 1833 appeared the celebrated criticism on Dr. Whately's Logic, of which the first thing to be said is that it is due to Dr. Whately himself that it had an audience to listen to it: its history, philosophy, and philology, would have fallen dead upon the previous generation. Accordingly this criticism, though most valuable as a logical dissertation, and of a necessity to be read which does not lessen with time, is nothing as a criticism; for it neither is nor proceeds upon a true view of the place and office of the work criticised. Nevertheless, it was one of the stimulants of the revival.

The meaning of the word *logic* has undergone much variation in different hands. It has been what the writer pleases, from the whole of the inquiry into truth and falsehood down to the investigation of the Aristotelian syllogism. This diversity of signification is probably near its end. There is a growing disposition to admit Kant's definition, which describes it as the science of the *necessary laws of thought*: it is said to treat of the *form* of thought independently of its *matter*. Though neither Aristotle nor his followers confine themselves within this definition, nor even so much as distinctly conceive it, all will acknowledge that the definition singles out the most important distinctive feature of their system. A few words on the relation of *form* and *matter* will be requisite.

When many things are thought of in one way, which way is neither governed nor modified by the difference between one thing and another, there is a common *form* of thought about distinct *matters*. Thus arithmetic is a formal science with reference to concrete magnitude: that 8 and 4 make the same as 4 and 8 is a form, a law of thought, which is not affected by the objects counted being yards rather than sheep, or pints rather than men. Pass into algebra, and the differences which are formal in arithmetic become only material: thus $8+4=4+8$ is but one material instance of the form $a+b=b+a$. Are we therefore to say that arithmetic and algebra are parts of logic? Certainly not: logic deals with the pure form of thought, divested of every possible distinction of matter. There is a form of thought in the above which is not even confined to number, and not even confined to magnitude: namely, that the manner in which we think of *part* and *whole*, in every possible case in which these words can apply, is wholly independent of the order in which the parts are considered as coming together. For example, the notions *animal* and *rational* are joined together in the mind when we think of *man*, but by a mode of junction very different from that called addition in arithmetic. Nevertheless, it matters nothing as to the notion arrived at whether we think of *animal* as subsequently limited by the notion *rational*, or of *rational* as subsequently limited by the notion *animal*. The pure form of thought is that which belongs equally to the last instance and to $8+4=4+8$; different matters, different modes of junction, under the common law that order of junction is indifferent.

We now set down the titles of various works of recent publication, and not difficult to obtain, being works which may all be recommended to the student who wishes to go fully into existing controversies, both as sources in themselves and as guides to others.

Paris, 1839–44, 4 vols. 8vo: Barthélemy St. Hilaire, 'Logique d'Aristote,' a translation of the 'Organon' of Aristotle, with notes. Paris, 1838, 2 vols. 8vo: Barthélemy St. Hilaire, 'De la Logique d'Aristote,' a description of the 'Organon' which gained the prize of the Institute. London, 1853, 2 vols. 8vo: O. F. Owen, 'The Organon of Aristotle,' an English translation. London, 1857, 8vo: J. H. M'Mahon, 'The Metaphysics of Aristotle,' an English translation. Berlin, 1842, 8vo: F. A. Trendelenberg, 'Elementa Logices Aristotelicæ,' extracts from Aristotle, translated in the article ORGANON, and notes. Edinburgh, 1854, 12mo: T. S. Baynes, 'The Port Royal Logic,' a translation from the French, with notes. Paris, 1840, 8vo: J. Tissot, 'Logique de E. Kant,' a translation highly spoken of. There is an English translation of Kant's Logic, not easily got, by T. Richardson, London, 1819, 8vo, collected with some other translations from Kant, under a title-page of 1836. London, 1851, 2 vols. 8vo (3rd edition, one or more since): John S. Mill, 'System of Logic, ratiocinative and inductive, being a connected view of the principles of evidence and the methods of scientific investigation;' a great and widely known work, which takes logic in the fullest extent of meaning: we think Mr. Mill would have done more justice to himself, and given a better notion of his subject, if he had taken a more descriptive title; the words which follow "Logic" are of no use, for the book will be "Mill's Logic" all the world over. With this work, and in reference to a large part of its contents, may be read Dr. Whewell's writings on philosophical method and history, especially London, 1858, 8vo, 'Novum Organum Renovatum,' and London, 1860, 8vo, 'The Philosophy of Discovery.' The 'Novum Organum' of Bacon himself, not to speak of the recent edition (Longman) of Leslie Ellis and others, which is a magnificent performance, may be easily and cheaply obtained in—London, 1858, 8vo, J. Devey, 'The Physical and Metaphysical Works of Lord Bacon,' Edinburgh, 1850, 8vo: T. S. Baynes, 'The New Analytic of Logical Forms,' a prize essay, the first treatise on Sir W. Hamilton's system, with a note by Hamilton himself. London, 1853, 8vo, 2nd edition: Wm. Hamilton, 'Discussions on Philosophy, &c.,' already mentioned. There is a writing of Sir W. Hamilton which, from its ephemeral character, may be forgotten, but which is very characteristic of the author, and contains logical discussion of permanent value; London and Edinburgh, 1847, 8vo: 'A Letter to A. De Morgan, Esq., on his claim[*] to an independent re-discovery of a new Principle in the Theory of Syllogism.' The prospectus of Hamilton's work on logic, which he did not live to complete, attached to this writing and to others, should not be forgotten. Edinburgh, 1858, 8vo: A. C. Fraser, 'Rational Philosophy in History and in System,' the programme of Sir W. Hamilton's successor, who was further known by—Edinburgh, 1856, 8vo, 'Essays in Philosophy,' a collection of reviews on philosophical subjects, from the 'North British Review.'

Of Whately's Logic, already mentioned, there are many editions; and the same of Dr. Watts's Logic, an old and well-known work, which deserved much higher praise than it received.

Oxford, 1856, 8vo, 3rd edition: H. L. Mansel, 'Artis Logicæ Rudimenta,' an edition of the old and celebrated compendium of Aldrich, with copious English notes; the easiest and best way in which a body of discussion on the old logic can be read. Oxford, 1851, 8vo: H. L. Mansel, 'Prolegomena Logica,' an inquiry into the psychological character of logical processes, a most acute work, opposed to all the views of this article. The same writer's article on Metaphysics in the new edition of the Encyclopædia Britannica (vol. xiv., 1857) will be very useful in conjunction with the 'Prolegomena.' London, 1857, 8vo: W. Thomson, 'An Outline of the Necessary Laws of Thought, a treatise on pure and applied logic; valuable by thought, brevity, eclectic character, and extent of plan. Oxford, 1850, 8vo: E. Poste, 'The Logic of Science,' a translation of the Posterior Analytics of Aristotle, with notes. Oxford, 1848, 8vo: C. P. Chretien, 'An Essay on Logical Method.' Oxford, 1851, 2 vols. (or books) 8vo: W. H. Karslake, 'Aids to the Study of Logic.' These works are all highly and justly commended by Sir W. Hamilton.

Edinburgh, 1857, 8vo: W. Spalding, 'Introduction to Logical Science' (reprint from the Encyclopædia Britannica), a thoughtful work, of much collection and discussion as to recently disputed points. London, 1856, 12mo: R. G. Latham, 'Logic in its Application to Language,' a grammatical application well worthy the attention of teachers.

Of writers who have called in mathematical principles and forms, we have the following works:—London, 1847, 8vo: A. De Morgan,[†] 'Formal Logic, or the Calculus of Inference, necessary and probable.' London, 1860, 8vo: A. De Morgan, 'Syllabus of a Proposed System of Logic.' This syllabus contains references to the author's papers in the Cambridge Transactions, in which most of his novelties were first broached. Cambridge, 1847, 8vo: G. Boole, 'Mathematical Analysis of Logic.' London, 1854, 8vo: G. Boole, 'Investigation of the Laws of Thought.'

There is an immense collection published, and publishing in France, under the name of 'Cours de la Patrologie,' by the Abbé Migne. This collection contains many writers whom the logician desires to have, but can rarely obtain: as Boethius, Abelard, Peter Lombard, John of

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[*] The reply which closed *this* controversy—all subsequent feud being on new grounds—is in the first Appendix to Mr. De Morgan's 'Formal Logic,' presently described.

[†] When controversial points are treated as in the present article, it is not fair that one of the parties to the disputes should take the appearance of an indifferent judge by writing anonymously. This note is therefore added to the name of the writer of this article.

Salisbury, &c., &c., and a dictionary of scholastic philosophy and theology. It is to be wished that the publisher should circulate in England a distinct prospectus of the writers whose logical works have been reprinted; and it may be added, that a small addition to the bulk of the whole work would make its mediæval logic nearly as complete as its theology. The volumes are sold separately, and are very cheap.

It is impossible to give any account of the history of the subject which was first analysed by Aristotle, and afterwards received from Zeno the Stoic, as is supposed, the name of *logic*. That history is not yet written in full. A history of one logical idea, that of the CATEGORIES, was published by Trendelenberg a few years since; and recently, as we are told, the first volume of a professed history of the whole subject has been published in Germany by Prantl, which comes down as far as Boethius inclusive. A sketch of leading points and names is given by Mr. Mansel, in the introduction to his edition of Aldrich, dwelling briefly on the connection with logic of Zeno the Eleatic, the sophists before Aristotle, Socrates, Plato, Aristotle, Theophrastus, Eudemus, Zeno and other Stoics, the Epicureans, Alexander of Aphrodisias, Ammonius, Simplicius, Philoponus, Porphyry, John of Damascus, Photius, Psellus, Blemmidas, Pachymeres, Leo Magentinus, George of Trebizond, Cicero, Apuleius, Augustine, Marcianus Capella, Boethius, Cassiodorus, Avicenna, Averroes, Abelard, Gilbert Porretanus, John of Salisbury, Peter Hispanus, Albertus Magnus, Thomas Aquinas, Duns Scotus, Occam, Raymond Lully, Buridan, Burley, Laurentius Valla, Rodolphus Agricola, Ludovicus Vives, Peter Ramus, Melancthon, Burgersdicius, Keckermann, Downame, Milton, Bacon, Descartes, Locke, Leibnitz, Hobbes, Gassendi, Clauberg, Arnauld and Nicole, Buffier, Le Clerc, Watts, Wolff, Baumgarten, Lambert, Ploucquet, Kant. So bare are the books of logic of all account of its history, that a mere list of the names which would be most prominent in such a history, by which the student may resort to biographical dictionaries or general histories of philosophy, is a valuable addition to such an article as the present.

The great points of elementary logical investigation are four in number: 1. The *name* or *term*, the representative of one object of thought, as distinguished from others, including a mode of thinking. 2. The *relation*, or mode of bringing two terms together, signified by a *copula* connecting two terms. 3. The *proposition* or *judgment*, a relation between two terms affirmed or denied. 4. The *syllogism*, deduction of a relation between two terms by means of the relations of the two to a third term. These points must needs include the consideration of all the laws of ratiocinative thought in action: surely, What? What else? What of them? and What then? are questions which point to all that can take place in a mental process by which thought leads to thought. Nevertherless, by certain restrictions which we hold to be purely arbitrary, logicians have curtailed their science, and made it appear to contain but a very small part of the processes of actual thought. In placing before the student a mere sketch of disputed points, we remind him that many things must be left unstated, many objections unprovided for. He must look for full assurance, either for or against, in writings of more extended character, and in discussions which are fully guarded by the use of defined technicalities.

First, as to the term or name, which may be in one word or in many. The old logicians drew the distinction between a name used as simply denoting an external object, such as might be thought of as existing without any mind to think of it, and the name used as thinking of the object in its mental relation to other objects. A *man*, thought of as an individual pointed out, or a quality, as *white*, the white of a particular white ball, were called names of *first intention*, or *first notions*. But *man* as a class, or an individual thought of as a member of a class, and *white*, as an attribute of classes, were names of *second intention*, or *second notions*. The distinction is precisely that now known as objective and subjective: and accordingly, we propose to consider things—not material things only—and the qualities residing in them, as belonging to the objective use of names; and classes, and the attributes by which we define classes, as belonging to the subjective use. Now though the logicians have always professed to cultivate second intentions, or subjective uses, the forms and the language of the syllogism have been strictly fashioned on the objective use, and allowed to remain so.

Next, it is clear that a name excludes as well as includes: every object of thought is related to *man*, for instance, either as *in* the name or *out*. The logician has always excluded the privative name, *not-man*, for instance, as all but useless: a certain practice of his own really makes it so. For he will have no *universe*—or total sphere of thought—except the whole universe of possible existence; or, at narrowest, the whole universe of objective reality. He forgets that, more often than not, the universe of the existing topic of thought is limited. We are talking of animals, for example, and nothing else: *not-man* becomes so definitely significative that we have a separate name for it, *brute*. Logic ought to give us that command of thought which will prevent our mental vision from being obstructed by the casual absence of a name; and it ought to investigate the *actual* form of thought, as well as possible scientific generalisation.

Thirdly, two names may be joined either as separate parts of a common whole, or as jointly separating the common part of two different wholes. Thus the class *animal* has the two separate sub-classes, *man* and *brute*: but *man*, under the name *rational animal*, is seen as belonging to the common part of the two wholes, *rational being* and *animal being*. We call the first procedure *aggregation*, the second *composition*. The first process is *mathematical*: *animal* is made up of *man* and *brute* after the same law of thought by which a square is made up of two triangles. The second process is deep in the nature of things, *metaphysical*: the combination of *rational* and *animal* into a being such as man is not conceivable as *aggregation* or *addition*, and no more. Nevertheless the logician does not admit this: he announces an object as the *sum* of all its attributes. The preceding distinction divides logic into two parts, which we call the mathematical and the metaphysical; not meaning that one part of logic is mathematics, and another metaphysics, but that the distinctive features of the two sides of logic are of prominent account, the one in mathematics, and the other in metaphysics.

The distinction of composition and aggregation was conveyed and implied in a few remarkable words of Aristotle, contained in his Metaphysics: "The genus is said to be part of the species; but in another point of view the species is part of the genus." Animal is part of man: the *whole* notion (all the attributes) of *animal* forms part (component) of the notion *man*. But *man* is part of *animal*: the whole class (all the individuals) of *man* form part (aggregant) of the class *animal*. This is the heading of a chapter in logic which only begins to be written in full in our own day: the logicians always threw the idea of attributes compounded of attributes into metaphysics, and retained the mathematical notion of class aggregated of classes for logic. The attributes which compound into an attribute were said to form its *intension*: the classes which aggregate into a class were said to form its *extension*. This distinction of extension and intension—or extent and intent—is now often styled that of extension and comprehension; the Mills, father and son, call it that of denotation and connotation; Hamilton, that of breadth and depth. The revival of the distinction, in logic, and as a separation of the two sides of logic, is mainly due to Hamilton: but he and his followers have made a singular misconception. In the above explanation it appears clearly that the logical *quantities* change terms in the opposed modes of speaking. *All* animal (all the attributes) forms *part of* the notion man: *all* man (the whole of the class) forms *part of* the class animal. According to Hamilton, the quantities do *not* change places. He affirms that when we say "All men are some animals," we speak[*] in depth; and that when we say "Some animals are all men" we speak in breadth. We shall not enlarge upon this distinction: we do not think it necessary to impress at length upon the reader that Hamilton's distinction is not the great distinction of the laws of thought. And such discussion would be the more inappropriate at this time, because Hamilton's logical lectures are on the eve of publication by Mr. Mansel, who may be expected to defend his principal well, if defence be possible, and who must either defend or surrender. And we are glad of the opportunity of calling the reader's anticipation to a work which will most surely contain a vast breadth and depth of thought.

Lastly, every logical term is postulated as having existence in thought, or existence in external reality, according to the universe in question. It is only as representing existence that a term is used in logic. Thus, when from every X is Y, and every Y is Z, we infer every X is Z, our premises are supposed to imply the assertions that X, Y, Z exist.

We now come to the *copula* or relation by which terms are connected, and the *proposition* or *judgment*, which asserts or denies the connection. And here the logicians admit only one copula into the form of the proposition: that is, *identification*, affirmed by *is*, denied by *is not*. If we say A goes before B, they call this proposition a material connection between A and B. They hold that the form of the above which is essential to its consideration in pure logic is "A *is* a thing which goes before B." And they further maintain that there are three fundamental forms of thought, which they call the principles of *identity*, *difference*, and *excluded middle*. Of identity, A is A; of difference, A is not not-A (or B, other than A); of excluded middle (or of *nothing between*), B is either A or not-A. That every thought of our minds must be fashioned so as not to contradict either of these principles is most evident; as evident as the things themselves; as sure as eggs are eggs. But the logician assumes a right to say that only these propositions are of the pure form of thought, true by the form: and that all others are true by the matter and not by the form. Because all assertion identifies something with something, and all denial separates something from something, he lays it down that identity and difference constitute the only forms of comparison of ideas, or the whole form. For ourselves, we believe that there is matter in the proposition "A is A," one specific relation, identity: we do not see why, except by arbitrary separation founded upon great importance, the process of identification and the relation of identity are declared to be of so different a nature from all other processes and relations as to make the difference of form and matter. To us the pure form of the proposition, divested of all matter, is the assertion or denial of the following:—X stands in relation L to Y. The proposition "X is X" is brought under the general form by two introductions of matter: L is identity, and X and Y are the same symbols.

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[*] Mr. Mansel (*North Brit. Rev.*, May, 1851), inverts this mode of reading. He will have 'some A is all B' to mean that all the *attributes* of the concept B are some of the attributes of the concept A; and 'all B is some A' to mean that all the *things* possessing the mark (or name) B are a portion of those possessing the mark A. We must leave the Hamiltonian logicians to settle among themselves which is which: that is, to array the two propositions—'Some animal is all man,' and 'all man is some animal'—under their proper banners.

What is the test of distinction between a consequence which is true by its form, and one which is only true by its matter? When the assertion is true by its form, it can only be refused admission by impossibility in its matter; and when it can only be refused admission by impossibility in its matter, it is true by its form: and by impossibility we mean incompatibility with the conditions of the universe understood. If the universe be the whole sphere of possible thought, the impossible is that which contradicts itself, and nothing else; a five-footed quadruped, for example. But if it be the terrestrial sphere of actual existence, the impossible is only the non-existent on earth; a rational quadruped, for example. If the universe be limited to the idea of animal, a stone is an impossibility. For instance, "A is A," and "A is not not-A," are true by form, in our view; how can they be denied? or rather, when can we doubt of admitting them? for assertion must be opposed to non-assertion, not to denial. Only when A contradicts itself. A horse which is not a horse, and a cow which is not a cow, are they the same things, or different? and must they be either one or the other? We leave the logicians to settle it; for ourselves we cannot tell: we do not see how to affirm, and we do not see how to deny. But we do see that "A is A" can only be questioned, whatever the result may be, when the matter of A is impossible; and we recognise it as therefore true in form.

Again, let X be an existing animal; it follows that the tail of X is the tail of an animal. Is this consequence formal or material? Formal, because this is true whatever a tail may be, so long as there *is* a tail; and it cannot be refused assertion except when X has no tail. A guinea-pig, for instance, puts this proposition out of the pale of assertion, and equally out of that of denial; the tail of a non-tailed animal is beyond us. There are those who will assert that the tail of a *non-tailed* animal is *no tail;* but we are satisfied that the *tail* of a non-tailed animal is just as much a *tail* as no-tail; and therein lies the contradiction and the impossibility. If we were clear that the tail of a non-tailed animal is no tail, we should know how to think of it; for we can think of every subject which comes under a predicate. This very guinea-pig is here produced by us because it has been brought forward by an acute thinker to prove that the consequence above given *is material,* and *not* formal. It has been made to prove that 'X is an animal, therefore the tail of X is the tail of an animal' is a special inference gained from our material knowledge of the thing thought about, and not a general inference necessitated by the universal laws of thinking. We answer that though the lack of tail in a guinea-pig is not a law of logic, but a material incident of the object, yet we know the *consequence* to be necessitated by the laws of thinking, because we must go to impossible matter, we must make the tail of X a non-existence, before we can refuse to assert it.

The establishment of ordinary syllogism requires two principles. First, the *convertibility* of the terms of a proposition: "A is B" gives "B is A." Secondly, the *transitiveness* of the connecting relation: "A is B" and "B is C" gives "A is C." The logicians affirm that the three principles of identity, difference, and excluded middle, are sufficient for the evolution of all the laws of syllogism. We are not aware that any one has ever made this good by actually deducing the two principles last named from the higher three. This must be done, if at all, without syllogism, for syllogism must not be taken for granted as a step towards its own establishment; and if, as we believe, it cannot be done, then the three principles do not possess that dominant and all-sufficient character which has been claimed for them.

The syllogism is the determination of the relation which exists between two objects of thought by means of the relation in which each of them stands to some third object, which is the *middle term.* In our view of the subject the pure form of the syllogism, when its premises are absolutely asserted, is as follows:—X is in the relation L to Y; Y is in the relation M to Z; therefore X is in the relation "L of M," compounded of L and M, to Z. In ordinary logic, which admits only the relation of identity, the actual composition of the relation is made by our consciousness of its *transitive* character. Thus X is Y and Y is Z, tell us that X is that which is Z. But an identical of an identical is an identical; whence X is Z. Again, X is Y and Y is not Z; here X is that which is not-Z: or X is not Z. The full syllogism is a collection of such singular cases: thus every X is Y, and no Y is Z, repeats "X is a Y, that Y is a not-Z," as often as there are XS in existence, and gives "every X is not-Z," or no X is Z.

The requisites of the copular relation, in the system of ordinary syllogism, are *transitiveness* and *convertibility. Any* relation which possesses these qualities may take the place of "is" in the common syllogism, without impeachment of its validity. Thus the word "fellow" may have transitive senses, and is always convertible: choose a transitive signification, under which we may say that when X is a fellow of Y, and Y of Z, then X is a fellow of Z. Take a common syllogism, such as—no Y is any Z, some YS are XS; whence some XS are not any ZS. For "is" read "is a fellow of," and for "is not" read "is not a fellow of;" the inference remains valid. Against admitting this extension it is argued that the inference is one of matter, not of form; but though every *instance* is material, or has its own matter, we maintain that the above inference depends for its validity only on those qualities which must be seen in *identity* before the *common* syllogism can be established.

The logicians are well aware that there are many copulæ which give inference by comparison with a middle term, and which are not what *they* call syllogisms; for instance, "A equals B, B equals C, therefore A equals C." They reduce such arguments to syllogism by stating the requisite combination of relation in a major premise, and affirming the case to come under the combination in a minor premise. As in "An equal of an equal of C is an equal of C; A is an equal of an equal of C; whence A is an equal of C." But A and C are really compared in the mind with a middle term B, and thence with one another. When $A=B$, $B=C$, are made to give $A=C$, the process of the human mind is guided by steps in which = is as truly a *copula,* or connecting relation, as "is" in "A is B, B is C, whence A is C." The *transitive* character of the copula is as much the dictator of the result in the first case as in the second.

Dismissing, for further consideration in RELATION, the extension to wider relations than those contained under "is," we shall proceed to point out the questions which have arisen as to the common forms of enunciation, and the systems of enunciation and of syllogism which have been proposed. After a few words on the common system, we shall notice the different proposals of Mr. Boole, Sir Wm. Hamilton, and Mr. De Morgan.

The common proposition is derived from the notion of assertion or denial, applied to *all* or to *some,* giving the universal affirmative and negative, every X is Y, no X is Y; and the particular affirmative and negative, some XS are YS, some XS are not YS. [SYLLOGISM.] Here *some,* as in all logical writings, means no more than *not-none,* one at least, many it may be, even all, possibly. When we say that some X's are not YS, we only mean to deny that the class X is entirely included in the class Y; the exclusion may be partial or may be total. The logical opposition of quantity, then, is not that of whole and not-whole or part; but of quantity asserted to be the whole, and quantity not asserted to be the whole.

The old writers on logic hardly speak of universal and particular *terms;* they apply these adjectives to the *propositions.* They say that a *proposition* is made universal by prefixing the word *omnis* to the *subject.* Later writers *quantify* both subject and predicate. They find out that "all XS are YS" means that "all XS are some YS;" that "no X is Y" means that "every X is no one of all the YS;" that "some XS are YS" is "some XS are some YS;" and that "some XS are not YS" is "some XS are not any of all the YS." And hence the well-known rule that while the quantity of the subject is indicated, the quantity of the predicate is determined by the quality of the proposition; particular in affirmatives, universal in negatives. But conversion of term and quantity is not allowed: "all XS are some YS" is never seen as "some YS are all XS." The usual forms of language are made to dictate restrictions to thought. We shall presently return to this point.

Mr. Boole's generalisation of the forms of logic is by far the boldest and most original of those of which we have to treat. It cannot be separated from Mathematics, since it not only demands algebra, but such taste for thought about the notation of algebra as is rarely acquired without much and deep practice. When the ideas thrown out by Mr. Boole shall have borne their full fruit, algebra, though only founded on ideas of number in the first instance, will appear like a sectional model of the whole form of thought. Its forms, considered apart from their matter, will be seen to contain all the forms of thought in general. The anti-mathematical logician says that it makes thought a branch of algebra, instead of algebra a branch of thought. It *makes* nothing; it *finds:* and it finds the laws of thought symbolised in the forms of algebra. [ALGEBRA, p. 199, § 9.] We cannot attempt, in this article, to do more than show, by one single case, how common algebraical operation is transformation from one logical equivalent to another. We shall choose the conversion of "to be both not-A and not-B is impossible" into "every thing is either A or B or both." Let A and B represent two objects of thought. Let 1 represent the universe, all that exists; let 0 represent the impossible, something that does not exist. Let = represent identity. Let A + B represent the class containing both A and B, with all the common part, if any, counted twice; let A—B signify what is left of the class A, when B, which it contains, is withdrawn. Let AB represent the common part of the notions A and B. Then 1—A and 1—B represent all that is not A and all that is not B; and the non-existence of everything which is both not A and not B is symbolised by

$$(1-A)(1-B)=0$$

The common rules of algebra transform this into

$$A+B-AB=1.$$

Now, $A+B-AB$ is simply the aggregate of A and B, without repetition, the part reckoned twice in $A+B$, if any, being withdrawn once. Accordingly the second equation means that A and B between them contain the whole universe; or that everything is either A or B, or both. We have put forward enough to enable an intelligent student to raise a string of difficulties; for the solution of most of which we must refer him to Mr. Boole's writings.

We now proceed to the discussion of Sir William Hamilton's system. At the outset the learned author puts into words a postulate * which no one would suppose had been left to him to demand. It is "that we be allowed to state in language what is contained in thought." We may trust Hamilton's learning for the fact that this postulate was never *announced:* but surely we shall feel inclined to ask, who has ever been timid enough not to use it, as wanted? Aristotle, we may answer, and nearly all his followers. There are cases in which Aristotle himself appears to doubt the right, or at least to waive the right, of pushing thought beyond the bounds of usual expression; and to this day logic has been circumscribed by this want of clear apprehension that language was made to express and extend thought, not to circumscribe it. The postulate ought to be pushed further; the logician ought to be allowed to state all that *can be* contained in thought; unless indeed we are to construe *is* as a junction of the present and future tenses.

Among the cases in which language did not find expression for possible thought, was the quantity of the predicate of a common proposition. The logicians, Hamilton at least, and most others we believe, affirm that thought *does* quantify the predicate; for ourselves, after much observation, we believe it does not. We believe that minds of ordinary cultivation, with whom logic has not been a study, when they have occasion to think that no quadruped is a fish, do *not* hold it in thought that they are speaking about *all* fishes, actual and possible. They may, by a process they never analysed, be able to *use* this implied truth; but we do not believe they ever held it in that way in which they hold the thought which is apt to find expression. Be this as it may, Hamilton believed, not only that a quantity is held in thought for the predicate of the ordinary proposition, but even that quantities *are* in thought which have never been expressed in language even by logicians. He accordingly applied—as had been done before him, though the results had not been worked into a logical system—*both* the quantities, universal and particular, to both subject and predicate. He thus put forward, as what *we have* in thought, eight forms of predication, to the statement of which we add some explanation, and some objection.

1. All X is all Y. This means that X and Y are coextensive terms; accordingly it is a complex† proposition, made by compounding "every X is Y," and "every Y is X." It is simply contradicted by the alternative of one or another of two other propositions of the system: Either "some Xs are not Ys" or "some Ys are not Xs."
2. All X is some Y. This is the same as "every X is Y."
3. Some X is all Y. This is "every Y is X."
4. Some X is some Y. This is "some Xs are Ys."
5. Any X is not any Y. In negatives, the word *any* takes the place of all, for the sake of grammar. We have here, "no X is Y."
6. Any X is not some Y. This is "some Ys are not Xs."
7. Some X is not any Y. This is "some Xs are not Ys."
8. Some X is not some Y. This proposition is not in ordinary use. It means that some of the Xs are not some of the Ys, even if they be others. To contradict it we must affirm that there is but one X and one Y, and that X identical with the Y. Consequently, here is a proposition which does not find its denial in the system.

Dr. Thomson ('Outlines,' &c.) admits the first seven of these propositions, but rejects the eighth; and constructs a system of syllogism accordingly.

That Hamilton really believed the above system to be in *common thought*,‡ and not the deduction of a postulated extension, is manifest. To this we object: but our greater objection is to the system itself. We have not seen any defence of the following points which has a single respectable* element, except the character of its producers. The introduction 1, of a complex proposition; 2. of a proposition which is not simply contradicted by any *one* other proposition; 3, of a proposition which cannot be contradicted at all in the system; 4, of a proposition compounded of two others *already in the system*.

The notation of the system is as follows. Woodcuts † resembling — and ⫟ are used for assertion and denial; a comma signifies particular quantity; a colon signifies universal quantity. Thus X , ⫟ : Y signifies "*some* X is not *any* Y." And the following diagram represents the syllogism, "all X is all Y, some Y is all Z, therefore some X is all Z."

X : — : Y , — : Z
, ————————

There is valid inference when the middle term is once at least taken universally, and one of the propositions at least is affirmative. We shall presently point out the canon of inference, when we have described a notation which we prefer. We refer the student to Sir W. Hamilton's own writings for the notation, &c. connected with his distinction of breadth and depth. We hold it quite useless to enter on the comparison of "all man is some animal," and "some animal is all man," as cases of a fundamental subdivision ‡ of logic into two parts; those who can may believe that, as asserted, one of these propositions is *metaphysical* and one *logical*.

Sir W. Hamilton invited the severest criticism: he challenged it to show that his system is not more correct§ in theory than that of Aristotle, and not preferable in practice. He affirmed that his system was intended to "place the key-stone on the Aristotelic arch," and that it succeeded in so doing. We hold him to be almost a miracle of learning, and, in every sort of psychological or metaphysical notion, except only when it is mathematical, we feel him to have a true genius for conception, a mighty power of execution, and a rare talent of expression. But when quantity is in question, his power is gone. Almost in a breath he tells us, first, that his two quantities, breadth and depth, are in reality one and the same quantity; and next, that the greater the one the less is the other ('Discussions,' &c. 1st. ed., p. 644*, 2nd ed., p. 699). He confounds equation of quantity with identification of quantified matter: he asserts that a proposition is "merely" equation of quantities. He uses the phrases "equation of quantities" and "coalescence of notions" as convertible; and the prize essay of an able student, published with his sanction, announces that "predication is nothing more or less than the expression of the relation of quantity in which a notion stands to an individual, or two notions to each other."

We now proceed to state Mr. De Morgan's views, and for brevity as well as for other reasons, we shall confine ourselves to mere statement, without proof or enforcement; referring to the works previously mentioned.

The proposition in its common form is objective, or, in old phrase, of first intention. It is also arithmetical in character: it either enumerates or speaks by total of enumeration, as in Every X is Y, All Xs are Ys. It is so far not distinguishable in character from a numerically definite proposition: "Some Xs are Ys" and "70 Xs are Ys" are forms which differ only by vague and definite enumeration.

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* Besides this principle, Hamilton announced another, which had been quite as much neglected as the former: and by merely lending the weight which his acumen and learning gave him to these two fundamental requirements of logic, he will have done much to promote it, even though his practice be not quite abreast of his preaching. "Whatever is operative in thought, must be taken into account, and consequently be overtly expressible in logic; for logic must be, as to be it professes, an unexclusive reflex of thought, and not merely an arbitrary selection—a series of elegant extracts—out of the forms of thinking. Whether the form that it exhibits as legitimate be stronger or weaker, be more or less frequently applied;—that, as a material and contingent consideration, is beyond its purview."

† This is denied. But if, of propositions A, B, C, A always make B and C follow, and B and C always make A follow, surely A is identical with the junction of B and C. What does A contain more than is in B and C compounded? And what less? A proposition is contradicted by alternative junction of two different propositions, of which neither contains the other: is it simple or complex?

‡ He published to the world the requirements for a prize essay to be written by his pupils, among which was the following:—"The reasons why common language makes an *ellipsis* of the *expressed* quantity, frequently of the *subject*, and more frequently of the *predicate*, though both have always their quantities in thought." In saying this, he was so fully satisfied that he had announced the principle of applying *every* quantity to the predicate of *every* proposition, that he made a charge of plagiarism of this principle against one who applied it after (as he supposed) seeing this announcement, and rested the proof on the (as he thought) obvious meaning of the sentence above. It is hardly requisite to say that "both have *their* quantities" is not the same as "both have *all* quantities," but generally means that one has one and another another. If any one had said that two persons "both have always their hobbies," no one would have gathered that the pair keep a pair of hobbies for their joint use. The present point, however, is the statement that this takes place in *common language*, and that the *ellipsis*, as he calls it, is only *frequent*, implying that the full expression is not infrequent.

* To the objection that 'All X is all Y' has no single contradiction, an eminent defender replied that it *has* a contradiction; and he produced it; 'All X is not all Y'; and Sir Wm. Hamilton assented: and both are right under a little admission of unusual construction. But the assailant had only objected that there was no contradiction *in the system:* and both Hamilton and his defender forgot to explain how this contradiction did not find its way *into the system*. The true explanation is that the system itself was founded, not on the laws of thought, but on an arbitrary extension of the application of language: and the end of it is that the Hamiltonian logic is *not* allowed to find language for all that is contained in thought. For both Hamilton and his defender have to go *out of the system* to find language for what must be *in thought* to those who think of the system, namely, the denial, when wanted, of the first of the propositions in the system.

† It will amuse the mathematician to see that Hamilton, to whom all mathematics was repugnant, stumbles upon + for his sign of negation, and — for his sign of affirmation.

‡ Sir W. Hamilton seems, *in logic*, to have nothing answering to the *attribute* which marks a *class:* he substitutes the concrete quality, treated as a class of individuals. He says that Leibnitz and Newton have *two* human natures, one apiece: that one attribute of Plato is '*some* Athenian.' This is quite true, and the treatment of the quality, under the notion of one quality for one individual, another for another, is good in its proper and very subordinate place. But it is not connected with the great distinction of comprehension and extension, hereinbefore noticed.

§ His completely quantified predicate is maintained by him to be necessary to the perfect representation of common thought. A living lesson on this point was soon given. Shortly after Sir W. Hamilton's death, an ardent admirer published a manual of his system for the use of schools. But though he had seen the objection to the form 'All X is all Y' having no contradiction, and Hamilton's admission and defence, he actually took 'Some X is not some Y' to be the contradiction required. And when the error was pointed out in a review, he continued to maintain it, and appealed to common sense for its truth, and to Hamilton's pupils (one of whom set him right) to vouch for its correct representation of the system. The author of the manual showed no want of acuteness in other things, and his book is a valuable and well-timed proof that Hamilton's system demands more than *is* in common thought, though not more than *may be* in the thought of those who will gain it.

The adoption of a definite universe, as already noticed, gives precision to the privative term, not-X, the rest of the universe when X is removed. Let not-X be denoted by x; not-Y by y, &c. And X and x are called contraries.* This introduction destroys the distinction of assertion and denial, except in a relative sense: the assertion that every X is Y is the denial that any X is y. Affirmation and negation must be distinguished as follows, A proposition true of X and x, false of X and x, is affirmative: a proposition true of X and x, false of x and X, is negative. Thus every thing is either X or Y is negative, though assertive in this form: it is true of X and x, false of X and X. It is to be understood that no term used fills the universe: names which belong to the whole universe, to one part as much as to another, cannot be of any distinctive force or meaning within that universe.

Let a proposition be called universal, when the whole universe must be examined to verify it: particular, when the examination of a portion of the universe may verify it. Let a term be called total, where every instance of it must be examined before the proposition can be verified: partial, when such complete examination may not be needed.

There are two forms of predication in use: the *cumular*, as in "all Xs are some Ys" and some Xs are not Ys (are distinct from all Ys); the *exemplar*, as in every (each, or any) X is some one Y, and some one X (perhaps not *any* one) is not any one Y. The cumular proposition speaks by collection; the exemplar, by selection. Grammatical correctness (representing a usual tendency of thought, though not an absolute law) allows either mode of expression in affirmatives, but demands exemplar expression in negatives; as in all Xs are not any Ys. The cumular and exemplar modes of expression have differences which will presently be further seen.

We first take the cumular proposition and syllogism. Let a term totally used, as X, be denoted by X) or (X; partially, by X (or)X. Let affirmation be denoted by two dots, or none; negation by one dot. Let propositions be distinguished by the quantities of their terms and the *quality* (affirmative or negative): this is found to make complete distinction. Thus (·) means a negative proposition in which both terms are particular: and X (·) Y is that proposition enunciated in terms of X and Y. It turns out to be "Everything is either X or Y."

There are eight forms of cumular predication: four universal, with four contrary (usually called *contradictory*) particulars. These are now given, with their symbols and usual readings: and the correctness of the distribution of the words universal and particular, total and partial, may be gathered by the reader from the definitions. Each universal (U) is followed by its contrary particular (P).

U. X)) Y. Every X is Y.
P. X (·(Y. Some Xs are not Ys.
U. X)·(Y. No X is Y.
P. X ( ) Y. Some Xs are Ys.
U. X (·) Y. Everything is either X or Y.
P. X) (Y. Some things are neither Xs nor Ys.
U. X ((Y. Some Xs are all the Ys.
P. X)·) Y. All Xs are not some Ys.

Contraversion—changing a name into its contrary—alters the quantity of the term, and the quality of the proposition: thus X)) Y is X)·(y and x ((y and x (·) Y. And a term and its contrary always enter one proposition *with different quantities*. *Conversion* is simply writing the propositional symbol inverted: thus X)) Y is conversely Y ((X. We shall now use the forms)) (·(&c. to signify the propositions.

Of contraries; one must be true and one false: either)) or (·(&c. Each universal simply contradicts one particular—the one with different quantities and quality; is inconsistent with, and therefore denies, the universals of different qualities; remains indifferent to the universal of different quantities and its contradictory; and contains the two particulars of the same quality. Thus)) contradicts (·(, that is, denies and is the only mode of denial; it denies)·(and (·) but not by simple contradiction; it co-exists with either ((or)·); and it contains and affirms ( ) and) (.

Each universal proposition has what we call *terminal ambiguity*: thus "every X is Y" may coexist with either "Every Y is X" or "some Ys are not Xs." The following is the list of propositions which, with reference to the ambiguity just noted, have what we call *terminal precision*. The symbols used to denote them are prefixed.

X)o) Y, compounded of X)) Y and X)·) Y. All Xs and other things besides are Ys.

X | | Y, compounded of X)) Y and X ((Y. All Xs are all Ys: X and Y are identical terms.

X (o(Y, compounded of X ((Y and X (·(Y. The Xs contain all the Ys and other things besides.

X)o(Y, compounded of X)·(Y and X) (Y. Nothing is both X and Y, and some things are neither.

X |·| Y, compounded of X)·(Y and X (·) Y. Everything either X or Y and nothing both: X and Y are contraries.

X (o) Y, compounded of X (·) Y and X ( ) Y. Everything is either X or Y, and some things are both.

Each kind of proposition is either simple or complex with respect to the other, according as we think of alternation or conjunction. Thus)o) is the junction of)) and)·); but)) is the alternative)o) or | |. Conversion and contraversion are under the same rules as before.

The preceding forms are completely arithmetical, and are truly particular cases of the numerical proposition, of which it will now be convenient to say something, as well as of the corresponding syllogism.

Let m X Y signify that m (or more) Xs are Ys; then m X y signifies that m or more Xs are not Ys. Let u be the number of instances in the universe; let x, y, z, be the numbers of Xs, Ys, and Zs: then $u-x$, $u-y$, $u-z$, are the numbers of xs, ys, and zs. A *spurious* proposition may exist: that is, one which by the constitution of the universe *must* be true. Thus if $x+y$ be greater than u, $(x+y-u)$ X Y must be true. Every proposition has two forms: thus

m X Y is $(m+u-x-y)$ x y
m X y is $(m+y-x)$ x Y
m x Y is $(m+x-y)$ X y
m x y is $(m+x+y-u)$ X Y

When one of the forms is spurious, the other contains a negative quantity, and is * inconceivable.

The contradiction or contrary of m X Y is $(x+1-m)$ X y. Hence deduce contradictions of the other forms. From m X Y and n Y Z we deduce $(m+n-y)$ X Z. That is, there is inference when the quantities of the middle term in the two premises together exceed the whole † quantity of that term. The following forms of syllogism may easily be investigated.

Premises.		Forms of conclusion.	
m XY	n YZ	$(m+n-y)$ XZ	$(m+n+u-x-y-z)$ xz
m Xy	n YZ	$(m+n-x)$ xZ	$(m+n-z)$ Xz
m XY	n yZ	$(m+n-z)$ Xz	$(m+n-x)$ xZ
m Xy	n yZ	$(m+n+y-x-z)$ xz	$(m+n+y-u)$ XZ

The proposition X)) Y is x X Y: the proposition X)°) Y is x X Y joined with $(y-x)$ x Y. And so of the rest.

In the more subjective view of logic, that is, in the *mathematical* side of it, the one commonly cultivated to the exclusion of the other, the term becomes the word expressive of a *class*, and the relation of class to class is that of inclusion or exclusion, total or partial. Each term, X, divides the universe into two classes, X and x. The following names may be applied to the *relations* of class:—

X)) Y X is a *species*‡ of Y; Y is a *genus* of X
X (·(Y X is an *exient* of Y; Y is a *deficient* of X
X)·(Y X and Y are *externals* of each other, or *co-externals*
X ( ) Y X and Y are *partients* of each other, or *co-partients*
X (·) Y X and Y are *complements* of each other
X) (Y X and Y are *co-inadequates* of each other
X ((Y X is a *genus* of Y; Y is a *species* of X
X)·) Y X is a *deficient* of Y; Y is an *exient* of X.

The propositions of terminal precision may now be stated under the following nomenclature:—

X)o) Y X a *subidentical* of Y
X | | Y X an *identical* of Y
X (o(Y X a *superidentical* of Y
X)o(Y X a *subcontrary* of Y
X |·| Y X a *contrary* of Y
X (o) Y X a *supercontrary* of Y

We now return to propositions of terminal ambiguity. When two propositions are joined together, between X and Y, and Y and Z, there is a valid syllogism, that is, one which yields a necessary conclusion, 1, when both premises are universal; 2, when, one premise only being universal, the middle term has *different* quantities in the two; or when the *spiculæ* turn the same way. And the conclusion is found by erasing the symbols of the middle term. Thus (·))·) gives a valid syllogism: for though)·) is particular, there is a universal and a particular quantity in the middle term. The conclusion is (··) or ( ). By this we mean that X(·)Y)·)Z gives X()Z, or that X(·)Y and Y)·)Z give X()Z. That is, if "Every thing is either X or Y," and "Some Zs are not Ys," it follows that "Some Xs are Zs."

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* No distinction is drawn between the words *contrary* and *contradictory*, whether as to terms or propositions.

* Not strictly inconceivable, to those who remember the full signification of the negative quantity as here defined. Thus (−7) XY means that −7 *or more* Xs are Ys: begin at the point of *more* at which logical predication begins to be conceivable, and we have '0 or more Xs are Ys,' a proposition which is simply spurious.

† This is what Hamilton calls the *ultra-total* quantification of the middle term. Lambert first thought of this principle: Mr. De Morgan, without any knowledge of Lambert, reconceived it and extended its use. Sir W. Hamilton, who did not know of Lambert till after this, states first, that he had himself thought of the principle and thrown it away; secondly, that Mr. De Morgan took it from Lambert: and this though Mr. De Morgan had explicitly stated that he never knew of Lambert's work till after his own paper on the subject had been published.

‡ Here is a departure from the common language. Usually X)o)Y is signified when we say that X is a species of Y, and Y a genus of X. We take the species as being, possibly, the whole genus: just as *some* is possibly *all*.

There are 32 valid forms. 1. Eight are *universal*, with universal premises and conclusion; being all which have differently quantified middle terms. They are as in)))),)))·(, &c. 2. Eight are *minor particulars*, with the *minor* (or first) premise particular, and a particular conclusion; as (·((·), ())), &c. 3. Eight are *major particulars*, with the *major* (or second) premise particular, and a particular conclusion; as (·))(, ((((), &c. 4. Eight are *strengthened particulars*, universal premises with the middle term similarly quantified in the two, and a particular conclusion; as in))((,)·()), &c.

In every syllogism, the terms being notions of class, there is a combination of premising relations in the concluding relation. Thus in "No X is Y, some Ys are Zs, therefore some Zs are not Xs," or in "X)·(Y()Z gives X)·)Z," we read that X is an external of Y, and Y a partient of Z, whence X is a deficient of Z. And we see that an external of a partient is a deficient. Apply this to all the cases. Thus in (·))·(, giving ((, we read that a complement of an external is a genus.

The propositions of terminal precision give syllogisms having conclusions also of terminal precision by joining two in which the middle term has different quantities; as in X(o)Y)o(Z, giving X(o(Z. This means that if everything be X or Y, and some things both, and if nothing be both Y and Z, and some things neither, it follows that the Xs contain all the Zs, and more. The combination of relations here seen is as follows: a supercontrary of a subcontrary is a superidentical.

When the notion of figure is taken into account [SYLLOGISM; RELATION], its force and meaning is best seen by stating the combination of relation in the different figures. Thus when we say a species of a species is a species, we speak in the first figure, and compare the minor with the major by the relation which the minor stands in to the middle and the middle to the major. When we read it thus—species and genus of the same are species and genus of one another,—we use the second figure, and compare both major and minor with the middle. When we say that those to which the same is genus and species are species and genus of one another, we use the third figure, and compare the middle term with both major and minor. And when we speak thus,—that to which another is species of species is a genus of that other,—we use the fourth figure, that is, the first figure with the concluding relation inverted.

We now come to the *exemplar* form, already spoken of. Let X) and (X signify *any one* X: let)X and X(signify *some one* X, it not being known, even if true, that we may say *any one*.

The list of propositions is as follows. Each universal is followed by its contradicting particular:—

U. X)(Y *Any* one X is *any* one Y. This means that there is but one X and one Y, and the X is the Y.

P. X(·)Y Some one X is not some one Y. Either X and Y are not both singular: or if both singular, not identical.

U. X))Y *Any* one X is some one Y; or every X is Y.
P. X(·(Y Some one X is not any one Y; or some Xs are not Ys.
U. X((Y Some one X is *any* one Y; or every Y is X.
P. X)·)Y Any one X is not some one Y; or some Ys are not Xs.
U. X)·(Y Any one X is not any one Y; or no X is Y.
P. X()Y Some one X is some one Y; or some Xs are Ys.

Omit the word *one* throughout, for *any* read *all* when the word is in italics, and we have Hamilton's[*] system, provided the first pair be not read as contradictions.

There are 36 valid forms of syllogism, both in the exemplar reading and in Hamilton's reading. All that is required is one affirmative premise, and one total occurrence of the middle term. In the exemplar system, the rule of inference is as above described for the cumular system. In Hamilton's system there is this modification: when the middle terms are of different quantities, a concluding term which is total, with a spicula turning a different way from those of the middle term, must be altered from total to partial, if its proposition be affirmative. Thus,)(() in the exemplar system gives)), but in Hamilton's system it gives (). Or, "Any one X is any one Y, and some one Y is some one Z," gives "Any one X is some one Z:" but "All X is all Y, and some Y is some Z," gives "Some X is some Z." Again,)((·(, in Hamilton's system, gives (·(, not)·(, as in the exemplar system. The reason of this difference will easily appear, on consideration.

The exemplar proposition is often used, as distinguished from the cumular. It is, for example, the proposition of geometry. When Euclid proves that *all* isosceles triangles are of equal angles at the bases, he shows that *any* isosceles triangle is so, and he demonstrates only to those who can see that nothing is assumed in his demonstration which limits the selection.

The numerical syllogism leads to a species of syllogism which is occasionally used, but cannot be reduced to a common syllogism. It is the syllogism of *transposed quantity*, in which one of the concluding terms enters with the whole quantity of the other, or of its contrary. For instance, "For every man in the house there is a person who is aged; some of the men are not aged; therefore some of the persons in the house are not men." Nothing has yet been printed on the laws of this syllogism of transposed quantity: the following brief rules will enable the reader to detect the cases, which are sixty-four in number.

Let a *particular* proposition which has a term of the whole quantity of an *external* term—that is, in another proposition—be called an *external universal*, the ordinary universal being called *internal*. The proposition has a *receiving* term; the other proposition has an *imparting* term. Let the receiving term be distinguished by a hyphen below its spicula; the imparting term by a hyphen above. Thus $\mathrm{X}\overline{)})\mathrm{Y})\cdot\underline{)}\mathrm{Z}$ means as follows:—Every X is Y; for every X there is a Z which is not Y. But there is no valid syllogism when a term taken totally imparts its quantity: in the case before us the only chance of a valid inference arises from allowing X, which enters partially, to impart its quantity; as in "Every X is Y; for every X there is a Z which is not Y." This being understood, and also that in forming the conclusion every imparting term must change its quantity, the rules for detecting valid syllogism are precisely those of the cumular syllogism already described. That is, any two universals, each of either kind, give a conclusion; and one universal of either kind and one particular, if the middle terms have different quantities in the two.

Then $\underline{\overline{(}})(\cdot\underline{\overline{(}}$, having two external universals, is valid, and gives)·). That is, from "For every Z there is an X which is Y, and for every X there is a Y which is not Z," we deduce "Some Zs are not Ys."

Again, $\underline{(}))\overline{)}$ has an external and an internal universal, and gives ((. "For every Z there is an X which is Y, and every Y is Z" gives Every Z is X. And $\underline{)}((\cdot\overline{(}$, having an external universal and a particular, with middle term of different quantities in the two, is valid, and gives)·). That is, from "For every Z there is something neither X nor Y; some Ys are not Zs," we deduce "Some Zs are not Xs."

Few propositions that ever come before the human mind require closer attention than these transposed syllogisms. They are easily demonstrated from the general forms of numerical syllogism; not so easily by independent thought.

We shall now proceed to compare the mathematical and metaphysical sides of logic. A term may be formed by junction of terms in two ways. 1. By *aggregation*, as in what we represent by (A, B, C), which stands for all that is in A, in B, in C, or in two or more. 2. By *composition*, as in what we represent by (A-B-C), or (A B C), meaning all that is common to all the three terms A, B, C. The contrary of an aggregate is the compound of the contraries of the aggregants: either (A, B) or (a b). The contrary of a compound is the aggregate of the contraries of the components: either (A B) or (a, b).

The term, considered as aggregated of aggregants, is viewed in *extent*; as a compound of components, in *intent*. For *total* and *partial* we now substitute the words *full* and *vague*, to get rid of the wrong opposition which total and partial suggest; for the term called *partial* is not necessarily partial at all, it is only not known to be total. And this ambiguity has led acute[*] logical writers into absolute mistake. In this matter we follow Hamilton, who justly and acutely remarked that "It is only as indefinite that particular, it is only as definite that individual and general, quantities have any (and the same) logical avail." The word *indefinite* completely describes the word *particular*, or *partial*, as commonly used: we only use *vague* as a shorter word. But the *universal* or *total* of logicians is more than *definite*: it is the maximum of definiteness, and we use *full* as more correctly descriptive. *Two-sevenths* is as *definite* as *all*.

Extent and intent are the two logical *tensions*. The elements of extent are aggregants; the elements of intent are components. When one tension is full, the other is vague; when one tension is vague, the other is full. Thus X) signifies that X is taken fully in extent, vaguely in intent; and)X signifies that X is taken vaguely in extent, and fully in intent. When a tension is full, an existing element may be dismissed, but a new one cannot be admitted; when a tension is vague, no element can be dismissed, but any new one may be admitted. Thus A,B))Y and X))AB allow A))Y and X))A; but not A,B,C))Y nor X))ABC. Again, AB))Y and X))A,B do not allow A))Y nor X))A; but they do allow ABC))Y and X))A, B, C.

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[*] Sir W. Hamilton mixed the exemplar and cumular forms in obedience to grammar. His system suggested the one before us, which its proposer holds to be a correction. Hamilton himself rejected the correction with his usual piquant scorn, declaring that it stands alone—in badness, that is—in the whole history of science. Those, therefore, who comply with his wish, will hand it over *entire* to Mr. De Morgan, who will accept it all, if given, but cannot claim it all.

[*] In Hamilton's system, 'Every X is Y' is read 'All X is some Y,' and 'Every Y is X' is read 'All Y is some X.' But ('Discussions,' &c., 2nd ed. p. 688,) he says that 'All X is some Y,' and 'Some X is all Y,' are incompossible, that is, cannot be true together, "unless *some* be identified with *all*." This supposition he treats as an absurdity: hard pushed in controversy, he was misled by the ambiguity on which this note is written. The *some*, even of his own system, is a *possibly-all*: how otherwise can he dare to render 'Every X is Y' by 'All X is some Y?' The junction of the two propositions determines the *universality* of the so-called *particular*. This looks very like nonsense; but the fault is in the language of the logicians. Substitute *full* and *vague*: the word *some* is *vague* in either proposition taken apart: but the junction restrains the *vagueness*, and turns the indefinite into a definite, *vague* into *full*. Just as in algebra one relation between two unknown quantities may leave a vagueness which a second relation turns into comparative definiteness. Our two propositions are xXY and yYX. The first gives $x =$ or $< y$; the second gives $y =$ or $\overline{<}\, x$, that is, $x - y$ and $y - x$ are neither of them negative; whence $x = y$, so that Y is full in the first proposition, and X in the second.

The word *incompossible*, which Mr. De Morgan attributes to Sir W. Hamilton, is in truth only revived by him. It is a very useful word.

Elements may, under certain conditions, be transposed from one term to another, without alteration of the import of the proposition. Universal propositions allow the elements of vague terms to be transposed: particular propositions allow the elements of full terms to be transposed. In universal propositions the transposition is made directly in negatives, by contraversion in affirmatives. In particular propositions the transposition is made directly in affirmatives, by contraversion in negatives. As instances X))A, B gives Xa)) B; AB))Y gives B)) Y, a; AB)·(Y gives B)·(AY; AB( )Y gives B( )A Y; AB(·(Y gives B(·(Y, a; A, B(·)Y gives A(·)Y, B, &c. And in all these cases the result of transposition is identical with the original.

Both extent and intent are to be considered in both sides of logic, the mathematical and the metaphysical. A class may be an aggregate or a compound; the class *animal* is aggregate of *man* and *brute;* the class *animal* is compound (common part of) the class *body* and the class *living*. An attribute may be an aggregate or a compound: the attribute *useful* is aggregate of the naturally and the artificially useful: the attribute *useful* is compounded of, or at least has *among* its components, *attainable* and *applicable*. But the conveniences of thought, though not its necessities, and whether by mere habit or by human constitution is not a question of logic, dictate an almost exclusive confinement of the notion of aggregation to that of class, and of the notion of composition to that of attribute. Accordingly, intent is of predominant importance in the metaphysical side of logic, and extent in the mathematical.

The mathematical form of thought builds upon the notions of *contained* and *excluded:* the metaphysical form upon the notions of *essential* and *repugnant*. The metaphysical form should be cultivated because, right or wrong, human beings are made to be metaphysicians, children most of all, uneducated persons more than educated. The *must be* and the *cannot be* are the strong points of our mental constitutions. We know all about *can* and *cannot* from our cradles: we never feel the same assurance about *is* and *is not*. A philosopher, in a dark age, may determine to set out with a knowledge of the naturally possible and impossible; but not even a philosopher ever pretended to set out with a knowledge of the existent and non-existent. Logic excludes actual metaphysics by declining to enter into the inquiry whether this or that use of the metaphysical *form of thought* be true or false in matter. But logic claims to interfere to give a *logical* correctness in the use of terms and relating notions: to prevent, for instance, a person who, rightly or wrongly, makes reason an *essential* of man, from pronouncing it to be *therefore* repugnant to the nature of brute.

Additional intent may diminish extent, but never increases it: additional extent may diminish intent, but never increases it. By continual introduction of new attributes we may, if speaking of things existing, not of possibilities of thought, curtail the widest class until we have brought it down to an individual. Thus *being* includes everything; material being is body; living body is animal; human animal is man; man of old time is ancient; go on thus until we come to ancient Roman general who conquered Gauls, and wrote his own campaigns, and we have the individual Julius Cæsar.

If we read our cumular propositions by the notion of enumeration of attributes, we have the following arithmetical reading by enumeration of attributes, just as "every X is Y," &c., show arithmetical reading by enumeration of the smallest * possible classes, that is, individuals.

X))Y. All the attributes of Y are attributes of X.

X(·(Y. Some attributes of Y are not attributes of X.

X)·(Y. Everything wants either some attribute of Y, or some attribute of X.

X( )Y. Some things want neither any attribute of Y, nor any attribute of X.

X(·)Y. Everything has either all the attributes of Y, or all the attributes of X.

X)(Y. Some things want either some attributes of Y, or some attributes of X.

X((Y. Some attributes of Y are all the attributes of X.

X)·)Y. Any attributes of Y are not some attributes of X.

The complete inversion of the quantities will be perceived. We now give a metaphysical nomenclature.

X))Y. X a dependent of Y; Y an essential of X.
X(·(Y. X an independent of Y; Y an inessential of X.
X)·(Y. X a repugnant of Y; and Y of X.
X( )Y. X an irrepugnant of Y; and Y of X.
X(·)Y. X an alternative of Y; and Y of X.
X)(Y. X an inalternative of Y; and Y of X.
X((Y. X an essential of Y; Y a dependent of X.
X)·)Y. X an inessential of Y; Y an independent of X.

The syllogisms are now described in a way which will suggest itself: thus (·))·) giving ( ), which read mathematically exhibits the combination "A complement of a deficient is a partient," will, when read metaphysically, give "an alternative of an inessential is an irrepugnant."

In the article PREDICABLES we shall add something on the extension which must follow the admission of contrary terms. In RELATION we shall enter farther upon the doctrine of figure, which is of no importance in any system in which only convertible relations are used, and quantities and terms are converted together. In PROBABILITY we enter upon the subject of belief.

When reduced to so brief an abstract as we have here given, a system of logic appears like a string of names. But the more names the more ideas; provided only that every name has meaning which is not merely repeated in any other. So far as the invention of words is analysis of ideas, or signifies the completion of such analysis, and prevents it from being lost, so far it is augmentation of power over ideas. Dr. Thomson well observes that "as the distinctions between the relations of objects grow more numerous, involved, and subtle, it [language] becomes more analytic, to be able to express them: and, inversely, those who are born to be the heirs of a highly analytic language, must needs learn to *think up* to it, to observe and distinguish all the relations of objects, for which they find the expressions already formed, so that we have an instructor for the thinking powers in that speech which we are apt to deem no more than their handmaid and minister."

It is very common to discuss the utility of the subject, in an article treating of it in general; but of all arguments, that about the utility of any branch of knowledge is the most useless. Allowing an infrequent exception here and there, those who have mastered the first difficulties of *any* branch of knowledge are all convinced of its utility; and with those who have not, and who have the boldness to form an opinion, there is no basis for an argument.

LOGISTIC. [PROPORTIONAL.]

LOG'OS, *λόγος*, the Greek for *a word*, is used as a theological term.

1. *The Jewish doctrine of the Logos.*

The phrase, *the Word* or *Memra of Jehovah* (מֵימְרָא דַיְיָ), occurs repeatedly in the Chaldee Targums, where it commonly stands in the place of יְהוָֹה (Jehovah) in the Hebrew original. There are, however, passages in which this phrase appears to denote a distinct personal existence; and many eminent critics, among whom are Bertholdt and Wegscheider, are decidedly of opinion that the Targumists intended it to apply to the Messiah; "plainly showing it to have been their belief that the Shechinah, or Word, as some of them indeed expressly say, would employ the future Messiah, when he should be born, as the instrument of his gracious designs, and would be joined to him in a personal union." (Bertholdt, 'Christol. Jud.')

Philo often speaks of the Logos, but his views on the subject are involved in much obscurity. He seems, however, to have had the idea of a two-fold Logos; the one denoting a conception in the divine mind according to which the world was created; the other a personal existence, the Son of God, partaking of the divine nature, though inferior to the Supreme God, the Creator of the world (δημιουργος), presiding over the universe, the instructor and guide of man, the High Priest and Mediator between God and man. These two ideas of the Logos he often confounds together. The passages from Philo are collected in Dr. J. P. Smith's 'Scripture Testimony to the Messiah,' book ii., cap. vii., sect. 4.

See also the descriptions of Wisdom and the Word of God in Prov. viii.; Wisdom of Solomon, x. 15–19; xi. 1–4; xviii. 15 (compare 1 Cor., xii. 4, 9, where the same actions are attributed to Christ); and in other parts of the Wisdom of Solomon and Ecclesiasticus.

These opinions are thought by some to represent the ancient Jewish doctrine respecting the word of God, corrupted by a mixture of heathen philosophy; and by others to have been wholly borrowed either from the Platonic philosophy or from the Magian doctrine of divine emanations and Æons.

2. *The Christian doctrine of the Logos.*

The only examples of the theological use of this word in the New Testament are found in the writings of John (Gospel, c. i.; 1st Epistle, i. 1; Rev., xix. 13). These passages are generally allowed to refer to Christ; but the sense in which Logos is to be taken, and the nature of the connection between this Logos and the person of Christ, are subjects of much dispute.

The Trinitarian expositors assert that these passages can mean nothing else than that the Logos is a distinct personal subsistence, which has existed from all eternity in a union of nature and of essence with God, which created the universe, and which was joined with a human nature to form the person of Christ.

The Arian doctrine represents the Logos as an emanation from the Deity, superior to all other created beings, and which supplied the place of a human soul in the person of Christ.

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* There is a termination to disaggregative separation; we cannot subdivide individuals. But if there be a termination to decompositive separation, we know nothing about it. We can disaggregate the class *mankind* into its constituent non-interfering indivisibles, or individuals: we cannot decompose reason into attributes, which all will agree upon as being primary and non-interfering, and not further separable. But this distinction is of no *logical* importance.

Most Unitarian divines consider it to be used either for God himself, or as an abstract term for the wisdom and intelligence of God which was fully imparted to Christ to fit him for his mission.

Those who attribute to the Logos a personal existence give different reasons for the origin of the name. Some explain it to mean the *speaker* or *teacher*, by metonymy, as Christ is called by John the Light, the Way, the Truth, the Life; others interpret it *the promised one*; and others consider that as speech (λόγος) is a *medium* of rational communication, so the name Logos is given to the *Mediator* between God and man, one who speaks to man in the name of God.

(The Lexicons of Schleusner, Wahl, and Bretschneider, *in loco*; Kuinoel, *Comment. in Lib. Hist. N. T.*, *Prolegomena in Johan.*, sect. 7; Lücke *on the Epistles of John*, in the *Biblical Cabinet*, p. 102; Dr. J. P. Smith's *Scripture Testimony to the Messiah*; Lardner's *Letter on the Logos*, *Works*, vol. x.)

LOGWOOD. [Hæmatoxylon.]

LOLLARDS, a religious sect which arose in Germany at the beginning of the 14th century, and differed in many points of doctrine from the church of Rome, more especially as regarded the mass, extreme unction, and atonement for sin. It took its name, according to some writers, from Walter Lollard, or Lolhard, who was burnt alive for these doctrines at Cologne in 1322; but it would seem that Walter rather received his name from the sect, than gave a name to it. The real origin of the term appears to be the German *lullen*, *lollen*, or *lallen*, to sing, with the well-known termination of *hard*, which is subjoined to so many German words; and it implied a person who was continually praising God in sacred songs. Lollard subsequently became a term of reproach for all heretics, who were supposed to conceal erroneous doctrines under the appearance of piety. In England, at the close of the 14th century, the earliest source was the invectives against the clergy in the poem by Langland of 'The Vision of Piers Ploughman,' and the name was afterwards bestowed on the followers of Wycliffe. Knighton, noticing the success of that reformer's doctrines (Twysd. 'Script.' x. col. 2664), says, "more than half of the people of England in a few years became Lollards."

LOMBARD, an ancient name in England for a banker. It was derived from the Langobardi, or Lombards, a company of Italian merchants, the great money-changers and usurers of the 13th century, who settled in England before the year 1274, and took up their first residence in a street of the city, still called, from them, Lombard Street. They appear to have been first employed in England as bankers or money agents for the popes, and in the reign of Edward I. there were four companies of Sienese merchants settled in London, under the title of Campsores Papæ.

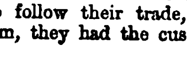
Stowe, in his 'Survey of London,' says, "Then have ye Lombard Street, so called of the Longobards and other merchants, strangers of diverse nations, assembling there twice every day," which had that name certainly before the time of Edward II. The meeting of which merchants and others there continued until the 22nd of December in the year 1568, "on the which day the said merchants began to make their meetings at the Bourse, a place then new builded for that purpose in the ward of Cornhill, and was since by her majesty, Queen Elizabeth, named the Royal Exchange."

The Italians were not only bankers and money-lenders, but wealthy merchants; and afforded the assistance of their capital by advances for wool and other productions of the country, on terms which often occasioned complaints of usury against them. Under the protection of the pope they prospered for a considerable time; but the loans advanced by them to Edward III. (who had made the Bardi and Peruzzi, merchants of Florence, his agents, his revenues and wools going through their hands, while they furnished his expenses during the war with France) so far exceeded the receipts, that he owed to one firm 180,000 and to the other 135,000 marks. These sums they lost; and the occurrence greatly shook the confidence of the Lombard bankers. They continued, however, to follow their trade, and when Henry VI. borrowed money of them, they had the customs mortgaged to them for security.

(E. A. Bond, in *Archæologia*, vol. xxviii. 1839.)

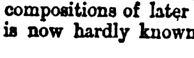
LOMBARDIC ARCHITECTURE. [Romanesque.]

LONG, a character used in old music, formed of a breve with a stem added, thus—



and equal in time, or duration, to two breves, or four semi-breves, &c. It is rarely met with in compositions of later date than the middle of the 17th century, and is now hardly known, except to the musical antiquary.

Still more obsolete is the LARGE, a character nearly in the above form, but the head is much more extended. *Ex.*:



This is the longest note ever used in musical notation, and equal to two longs, four breves, &c.

LONGITUDE and LATITUDE. These terms mean different things as applied to a point of the earth or a star in the heavens; and we must accordingly distinguish between *geographical* latitude and longitude and *celestial* latitude and longitude.

The latitude of a star in the heavens is its angular distance from the ecliptic, measured on a great circle drawn through the star and pole of the ecliptic. It differs from the Declination only in this, that the ecliptic is used instead of the equator. The longitude of a star is the angle made by the circle on which latitude is measured with the circle which passes through the pole of the ecliptic and the vernal intersection of the equator and ecliptic. Thus a star on the ecliptic has no latitude, and one which lies directly between a pole of the ecliptic and the vernal equinox has no longitude. The use of celestial longitudes and latitudes has in great measure been superseded by those of right ascensions and declinations.

The meaning of the term geographical longitude is the same whether we consider the earth as a sphere or a spheroid. It is the angle contained between the plane of the meridian of the place, and that of some one meridian which is fixed on as the starting-place. Thus we choose the observatory of Greenwich, and the French that of Paris, as being in the first meridian; and while we express the relative position of the two observatories (in longitude) by saying that Paris is 2° 20′ 24″ east of Greenwich, the French describe Greenwich as 2° 20′ 24″ west of Paris.

It is usual to measure terrestrial longitudes in time [Angle; Time], the whole circuit of the globe being supposed described (as in the diurnal motion) in 24 hours. It is also usual to reckon longitudes to 180° east or west, without proceeding farther. Thus a motion in longitude of 185° east will bring the traveller into 175° of west longitude. In astronomical writings, however, longitudes (both geographical and celestial) are measured all round the globe.

Supposing the earth to be a sphere, the latitude of a place is the angle subtended at the centre by the arc of the Meridian intercepted between the place and the equator. This angle is equal to the altitude of the pole of the heavens at the place; and the determination of the altitude of the pole is the method usually resorted to for determining the latitude. But the earth not being precisely a sphere, but a spheroid [Geodesy], the zenith line (which is a perpendicular to the tangent plane) does not pass exactly through the centre, and the altitude of the pole is not precisely the angle subtended at the centre by the arc of the meridian. Still, however, the altitude of the pole is called the latitude of the place; and it must be distinctly understood that a latitude, astronomically determined, is the angle made by a line which is vertical at the place with its projection on the equator. The angle subtended at the centre of the earth by the arc of the meridian is less than the altitude of the pole by a number of seconds, equal to

$$\frac{\epsilon}{\sin 1''} \times \text{sin twice the latitude,}$$

where ϵ is the Ellipticity. Assuming this at $\frac{1}{300}$, the above is such a proportion of 11½′ as the sine of twice the latitude is of unity.

The reason why the preceding is not of more importance in the construction of maps lies in this, that when a large portion of the earth is mapped, the scale is necessarily too small to make such an error of any consequence; and when a small portion of the earth is taken, the error is nearly the same in every part of the map, and relative positions are not sensibly affected.

The method of finding longitudes and latitudes is given in the next article. The history of this problem, or rather of that of finding the longitude in particular, divides itself into two portions: the first, or the account of the real progress of the problem, is so mixed up with the history of astronomy and horology, that it would be useless to attempt it within any limits which we could afford; the second is that of the speculators who have misunderstood the problem, and is not worth the recital. Since, however, there are still persons who imagine that some mysterious *method* is yet attainable, by which the longitude is to be found, and since the conductors of the newspaper press are not all sufficiently aware of the state of the problem to prevent the insertion from time to time of paragraphs which create a most erroneous impression, we shall briefly point out the source of the fallacy which has misled so many persons.

The determination of the longitude requires simply accurate instruments for the measurement of the positions of the heavenly bodies, and one or other of the two following—either perfectly correct watches, or perfectly accurate tables of the lunar motions. The legislature of Queen Anne, which passed an Act offering a reward for the discovery of the longitude, the problem being then very inaccurately solved, for want of one or the other, good watches or lunar tables, never contemplated the invention of a *method*, but only the means of making existing methods sufficiently accurate. And the legislature of George III., which repealed the former Act and substituted another, specifically limited the reward to those who should either proceed by improvement of chronometers or of lunar table. The rewards which were given were to Harrison for the former, and to Mayer's executors for the latter. The latter Act is now repealed, and there does not exist any parliamentary offer of a sum of money for further improvements.

Many persons, imagining that, as in the case of the quadrature of the circle, &c., a theoretical difficulty existed, have employed themselves in endeavouring to invent a method, imagining that they should obtain the prize held out by the legislature. Some persons still occupy themselves in this manner; and it is impossible to persuade them either of the repeal of the Acts of Parliament, or of their having mistaken the nature of the difficulty, which is now, for all practical purposes, entirely conquered. It is impossible to find the latitude of a place without knowing the position of the equator in the heavens, or the longitude without knowing the meridian of Greenwich. The equator has a real existence in the heavens, since its pole is the immovable point of the heavens, which can be detected (though it is not absolutely occupied by a star) from observation of the motion of the stars, which always preserve their distance from the pole. But the meridian of Greenwich, a purely arbitrary circle of the earth, determined merely by the will of Charles II., that an observatory should be built on a certain hill near London, has no representative in the heavens. The only method, then, of finding longitude of the heavenly bodies is by finding the hour of the day which it is at Greenwich, at a particular hour on the spot whose longitude is required. It is then known how much of 360 degrees is revolved through by the earth in the period which brings a star from the meridian of the place upon the meridian of Greenwich, or *vice versâ*; and this angle is the longitude. A watch which goes correctly and is set at Greenwich will carry the time at that place all over the world; or a celestial phenomenon, of which the Greenwich time may be predicted, will, if the moment of its happening be observed at any other place, give the difference of times at the moment of observation. Any proposal for finding the longitude *astronomically*, which does not depend on one or the other of these principles, is useless, unless it be that of actually measuring the distance between the given place and Greenwich, the latitudes of both being known. Whether it be *possible* to use any other than astronomical means for the purpose, it would be presumptuous to decide; but there certainly is no other method which offers the most distant prospect of success.

LONGITUDE AND LATITUDE, METHODS OF FINDING. We shall classify the various modes of determining geographical latitude and longitude, partly by the instrumental means of the observer and partly by the nature of the phenomena. The problems are of course the same whatever instrument is employed, for the latitude of a place is the altitude of the pole of the heavens at that place, and the longitude is the difference between the time on the first meridian (we shall always suppose Greenwich to be the first meridian) and the time at the place, at the same physical instant.

Determination of the Latitude at Fixed Observatories and Independently.—1. In determining the latitude at fixed observatories which are furnished with accurate circles, mural, transit, or altitude and azimuth circles [CIRCLE], the altitudes or zenith distances of circumpolar stars are observed above and below the pole. When these are properly reduced, the place of the pole (which lies between the places of upper and lower culmination of each star) is known, and hence the latitude is found. The first object of all astronomers is to fix the latitude of their place of observation, and the details of this operation will be found in the beginning of most of the published series of observations. The account of the latitude of Greenwich in the Greenwich Observations for 1836, p. lviii., of Cambridge in the Observations of 1833-4-5, and of Edinburgh, 1834-5, may be consulted by those who wish to know what the process is, with the most perfect means which we at present possess.

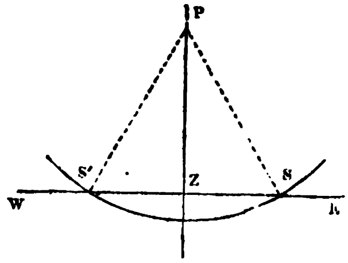
2. Again, if the altitudes or zenith distances of the sun be observed several days before and after the summer and winter solstices, the altitude or zenith distance of the middle point, that is, of the equator, may be deduced. Since the tables of refraction have been perfected by Bessel, these observations give a satisfactory latitude. Both methods may be considered to be independent, as they do not draw their data from other observatories, and no great accuracy is required in the solar tables to reduce the observations of the sun to the solstice. (Pond's 'Lat., Greenwich Observations,' part v.)

In the observatories of Europe, and generally where the visible pole of the heavens is tolerably high, the latitude is best determined by circumpolar stars; near the equator an independent latitude must be deduced from circumsolstitial observations.

3. Before the introduction of circles, the latitude in fixed observatories was derived from combining two instruments, the mural QUADRANT and the ZENITH SECTOR. The zenith distances of stars near the zenith, and to the north or south of it, were observed by the zenith sector, and also the distances of the same stars from the pole or the equator by the quadrants; hence the arc between the pole and zenith (the co-latitude), or between the zenith and equator (the latitude), was deduced. The place of the pole was found on the north quadrant from circumpolar stars, and the place of the equator on the south quadrant, from observations of the sun near the solstices, as we have described above. When the present zenith tube was erected at Greenwich, one of its intended uses was to perform the same office for the mural circle as the original zenith sector did for the quadrants.

Determination of the Latitude Differentially.—1. The ZENITH SECTOR, when of the proper size and construction, is perhaps the most accurate instrument for determining latitudes *differentially*, that is, assuming data which are either known or can be obtained from fixed observatories. With this instrument, the meridian zenith distances of several stars which pass near the zenith may be observed with great certainty; and as the polar distances of those stars are or may be determined at first-rate observatories, the polar distance of the zenith, or the co-latitude, is known. The latitudes for the trigonometrical survey of Great Britain are thus deduced by comparison with Greenwich, the instrument employed being a very fine 8-feet zenith sector by Ramsden. With a better knowledge of the proper motion of the stars, the sector might be used at two places, and the arc between those places obtained from observations of the same stars at two epochs, without reference to any other observations; but at present it is safer, when practicable, to refer directly to corresponding observations made at a fixed observatory.

2. Another differential method has lately been much used (at least by continental astronomers), in which the transit instrument alone is employed. [TRANSIT.] The axis of the instrument is placed north and south, and carefully levelled, in which case its line of sight will describe the prime vertical. In the figure, let P be the place of the pole, Z the zenith, E Z W the prime vertical, which is also the line described by the middle wire of the telescope when it revolves. Let a star, of which the polar distance is well known, be observed at S and S', and the times noted. Then P S, the polar distance of the star, is known, and the angle S P S' is equal to the time between the observations, and consequently ½ S P S', or S P Z, is known; hence we have S P and S P Z in the right-angled spherical triangle S P Z, and $\tan PZ = \tan PS \times \cos \angle SPZ$, from which P Z, or the co-latitude, is obtained. This is perhaps the most accurate mode of determining the latitude with moderate instrumental means. The transit should be reversed on alternate nights, so as to get rid of the effect of imperfect collimation or unequal pivots, and the level applied repeatedly before and after the observations. The method depends mainly upon the delicacy of the level and the perfect truth of form in the pivots, and when all precautions are taken the results are surprisingly good. The supports of the instrument must also be perfectly steady during the levelling and the observation. Differences of latitude may be determined by the transit instrument independently, by observing the same stars at the two stations. In this case any error in the assumed polar distance of the stars will not affect the accuracy of the result.



3. If an observer can carry with him a circle, either an altitude and azimuth, or a repeating circle, he may determine the latitude by circumpolar stars independently: but it is better to observe the zenith distances of well known stars several minutes before and after they pass the meridian.* [CIRCLE; REPEATING CIRCLE.] The reduction to the meridian is easily computed [REPEATING CIRCLE], and the places of the stars inserted in the 'Nautical Almanac' are sufficiently accurate. It is advisable to observe stars at different zenith distances from 70° on each side, to near the zenith, because if there be any fault in the instrument which depends on the zenith distance, the stars will be affected similarly on both sides of the zenith, that is, the zenith distances to the north and south will both be too large or too small. Now as the co-latitude is equal to the zenith distance ± the polar distance when the star is north of the zenith (+ when observed above the pole and − when observed below) and is equal to the polar distance −zenith distance when the star is south of the zenith, it is clear that an error in the zenith distance will have precisely opposite effects on the co-latitude deduced from a north and from a south star. Besides, the coincidence or discrepancy of the observations will afford a tolerable notion of the instrument and the observer, and of the value of the final result. The repeating circle was at one time over estimated, and perhaps at present is not quite rated at its true worth. A careful and intelligent observer will come very near the truth with it, or with the altitude and azimuth circle. Both are rather troublesome to use, and both require either a very solid support, or a second observer to read the level while the first observer bisects the star and notes the time. Neither can they be considered as portable in ordinary circumstances, when large enough for convenient use. The altitude circle should scarcely be less than 12 inches in diameter in either construction. On the whole we are inclined to prefer the repeating circle as a travelling instrument, and the altitude and azimuth for a permanent situation;

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* The number of minutes which it will be prudent to observe depends on several circumstances. If the time is known to one second, which it ought to be, the observations may be commenced when an error of 1^s in the time will affect the latitude 1″. In ordinary cases, and for observers who do not understand the reason of the thing, 10^m on each side of the meridian is a sufficient direction.

but it must be confessed that few observers have the patience or skill to get the greatest possible accuracy out of either. The observations should be confined to stars, as neither of these instruments will keep its adjustments well under the sun.

The repeating circle was used by the French astronomers to determine the latitudes in their great survey. Since that time the instrument has been much better made, and the catalogues of stars which have issued from Königsberg, Greenwich, and Cambridge, have supplied more accurate and convenient means of using it. If the levels are very good and sensible, we think that the observations of one fine night, everything being favourable, should bring out the latitude within 2" or 3".

4. The last class of instruments to be noticed is that of reflecting instruments, including the reflecting circle of Troughton, the repeating reflecting circle of Borda, and the sextant of Hadley. These will be described under the article SEXTANT, as the title best suited to their essential quality of reflection. At present we must suppose a general knowledge of their nature. And first we will suppose the observer to have a stand and a mercurial or other horizon. In this case, standard stars should be observed several minutes before and after the meridian passage to the north and south, between the altitudes of 15° and 60°, and as much as possible in pairs, that is, for each star to the north, a star to the south should be observed about the same altitude, or two, one higher and the other lower, so that the mean altitude should nearly correspond. Whatever errors may exist in the division, glasses, &c., will be the same in each star of the pair, and as the error will affect the latitude differently, the mean latitude will be free from the error very nearly. In this way several pairs may be observed, taking the stars of the 'Nautical Almanac,' and the mean of the whole will come out very near the truth. With a good sextant or circle, and a mercurial horizon, we believe that a careful observer would get the latitude within 5", in one fine night. It is, however, supposed that everything is favourable, and especially that the instrument is supported on a stand. This is absolutely necessary for the accurate observation of stars, which dance very perplexingly when the instrument is held in the hand, and a high power applied. If a stand cannot be afforded, the sun is far the best object to observe with a reflecting instrument. It is always supposed that the observations are made for several minutes before and after the meridian passage, and the time noted for computing the reduction to the meridian. The meridian altitude of the sun, such as it would be if observed on the meridian and freed from instrumental and other errors, is then computed, and as the longitude of the place is known, at least approximately, the declination of the sun at its passage over that meridian may be computed from the 'Nautical Almanac.' The meridian altitude + the south declination of the sun, or — the north declination, is, in the northern hemisphere, the co-latitude of the place. With Troughton's circle, the limbs are alternately observed, to get rid of the sun's diameter, and the number of observations, forwards and backwards, should be equal, so as to get rid of the index error. With the repeating reflecting circle, the observations should also be of the upper and lower limbs alternately, and should be carried quite round the circle, so as to get rid of excentricity. In the sextant the index error should be carefully determined before and after each day's observations, and the alternate limbs observed exactly as with the circles. There is, however, no way of getting rid of excentricity in the sextant by observing one object, and any fault in determining the index error will vitiate the latitude to half its amount. While the circles will probably give a latitude to nearly 5", with a very careful series of observations of the sun, the sextant used with equal care might be out 10" or 15". It is evident therefore, that where accuracy is an object, the observer ought, if possible, either to use a circle or to mount the sextant upon a stand, and observe stars as we have above described. It is an additional reason to carry a stand, when practicable, that in low latitudes the sun cannot be observed at all for the latitude, nor any object which is elevated 65° or 70°. In this case stars must be used; and without a stand, the observation, using high magnifying powers, is difficult and unsatisfactory. In speaking of the horizon we always mean a mercurial horizon, except another is specified. The glasses of the roof should be truly plane and parallel, but by reversing the horizon for half the observations any error of this kind is destroyed. The mercurial horizon is unfortunately heavy and inconvenient, and troublesome from its tremors wherever there is any motion. Several substitutes have been used. Oil or treacle has been adopted with good success where the shaking from carriages, &c., has prevented the use of mercury. Sometimes a piece of glass is set horizontal by a level applied to its surface, or by a fluid below it, so as to get a reflecting surface, but these generally absorb too much light to be used conveniently for stars, and are not very trustworthy. The best substitute seems to be a piece of speculum metal, ground plane, and laid horizontal by a level. It is certainly the brightest, and therefore the best for stars, but it must be remembered that horizons which are not self-regulated, by being fluid, are scarcely to be trusted under a hot sun. Troughton's reflecting circle is rather heavy, and reading three verniers for every observation is troublesome, especially at night, but it is very accurate, and fewer observations are required. Borda's reflecting circle may be made much smaller and lighter, but demands the most exquisite workmanship, a greater number of observations, and more reduction. The simple sextant is more manageable, but requires greater precautions and checks in its use. But with any of these a skilful observer will get the latitude very nearly. Sextants are made of all sizes from 10 inches radius (which is probably not so good as 8 inches) down to the snuff-box sextant of 1¼ inches radius. For travellers who cannot afford to carry much weight, the 3-inch sextant is very convenient. In a communication to the Royal Astronomical Society, Mr. Lassell states, that with a 3-inch sextant made by Dollond, which packs up, stand, horizon, and all, in a box 4·3 inches square and 2·7 deep, he found that he could get the latitude within 10", and the time to 1s·0 by observations of stars. The horizon was of speculum metal, ground by himself, and set true by a level. The observations sent with the account completely justify Mr. Lassell's opinion, but one observer differs more from another in sextant observations than in any other class of astronomical instruments; with the snuff-box sextant, altitudes may be got within 1'. The state of the barometer and thermometer must be noted at the time of all observations for the latitude, in order to compute the true refraction. At the same time we may remark, that if the observations be *balanced*, that is, if the altitudes to the north have nearly corresponding altitudes to the south, the refraction will affect the observations like an instrumental error, and the variations depending on the barometer and thermometer will be quite insensible.

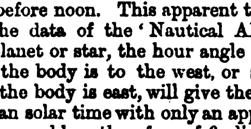
5. Observations of Polaris may be taken at any time for the latitude, and there are tables for *approximate* reduction given in the 'Nautical Almanac' for each year.

6. At sea the sextant is the only instrument which can be used, and the latitude is generally got by observing the altitude of the sun's lower limb when on the meridian, above the sea horizon. This is rather a rude process, but the resulting latitudes are generally true to 1', or at worst to 2'. The moon, since 1834, the date of the improved and extended 'Nautical Almanac,' may be very conveniently used for finding the latitude at sea, and the brighter planets and stars are often observable on the meridian. The latitude may also be deduced from two altitudes of the sun, and the time elapsed between the observations, or indeed from any two altitudes of two known celestial bodies, one of which is near the meridian, and the other distant from it, as persons not acquainted with spherical trigonometry may satisfy themselves on the celestial globe. There is a considerable difficulty in seeing the sea horizon by night, which is somewhat reduced by getting as near the level of it as you can.

Determination of the Longitude.—The determination of the longitude of any place on the earth's surface, astronomically considered, resolves itself into two parts, the finding the time at the place of observation, and finding the time, at *the same moment*, on the first meridian (we shall always speak of Greenwich), or at any place the longitude of which from Greenwich is well known. It will be more convenient to classify the methods of finding the longitude by the phenomena than by the instruments.

Determination of Time at the Place.—1. This is best and most easily done by a transit instrument, and the time, when found, is kept by a clock or chronometer. [TRANSIT.] The transit however is neither a very portable instrument, nor is a proper situation for it, we mean one sufficiently steady, readily found.

2. The time can also be found from the altitude of the sun, planets, or stars out of the meridian. Thus let P be the pole, Z the zenith, and Z S the zenith distance, or S H the altitude of any heavenly body, the right ascension and declination of which are well known, and consequently the polar distance P S. From these data and P Z the co-latitude of the place, the angle Z P S can be computed, called the hour angle, and this, if the body be the sun, and to the west of the meridian, is the *apparent* time after noon; or if the sun be to the east, the hour angle is the *apparent* time before noon. This apparent time is easily reduced to *mean* time with the data of the 'Nautical Almanac.' When the object observed is a planet or star, the hour angle being added to the right ascension when the body is to the west, or subtracted from the right ascension when the body is east, will give the sidereal time, which can be reduced to mean solar time with only an approximate knowledge of the longitude. The problem therefore of finding the time consists generally in observing the altitude or zenith distance of any known object, and determining the hour angle from it. The repeating or altitude and azimuth circles are very fit for this purpose, but the most usual and portable instrument is a reflecting circle or sextant with its horizon and a chronometer. The observations of altitude should be made as much as possible on the prime vertical, that is, when the object is east or west. Again, to get rid of instrumental error, and also to save computation, the sun should be observed, when



convenient and possible, at the same altitude morning and evening. We should also recommend when the sun is observed that both limbs should be observed without moving the index. For instance, if in the morning the sun were about 14° high, set the instrument to 30°, note the instant when the upper limb by reflection touches the upper limb seen in the horizon, read off the angle very carefully, wait till the lower limbs form their contact, and note the time. Then set to 31° 30′ or 32° and proceed as before, and repeat the operation, having again set forward 1° 30′ or 2°. The observer has then several checks without trouble, for the time in which the sun rises through a diameter will be sensibly equal or vary uniformly; and in like manner the times of rising through 1° 30′ or 2° will point out if any of the usual errors have been committed. In the afternoon the same process should be repeated in an inverse order, and the time of apparent noon deduced from each pair.* It is to be understood as a universal rule, that the index error is to be carefully determined, and the barometer and thermometer noted whenever observations of altitude for time or latitude are made.

3. The same mode of observing equal altitudes might be applied to stars, but the observations would be extended to very inconvenient hours, and it is *nearly* as accurate to observe two bright stars, one to the east and the other to the west, and if possible at about the same altitudes. Each star will then give an error of the chronometer, and if the altitudes are rightly observed, the *same* error of the chronometer. If the errors do not agree, a mean will come nearer to the truth than either of them separately; but if the stars have not the same polar distance, the effect of a given error in altitude upon the hour angle must be computed for each, and the difference between the chronometer's errors divided in this ratio. Thus, suppose the eastern star gives a chronometer error of $25^{s}\cdot0$ fast, and the western star an error of $28^{s}\cdot0$ fast, while an error of 1′ in the altitude of the eastern star causes twice the error in the deduced hour angle that a similar error of 1′ does in the western star; the concluded true error should be $27^{s}\cdot0$, instead of the mean error $26^{s}\cdot5$. The reader will see that if the observations are made at exactly the same altitude, any mistake as to the index error, refraction, or any instrumental defect, is thus got rid of without much trouble. But, as has been mentioned before, very perfect observations of stars with reflecting instruments can scarcely be made unless the instrument is mounted on a stand. From good sets of observations of a star east and a star west, the time may be determined to $0^{s}\cdot3$ or $0^{s}\cdot4$. The time is required to reduce circum-meridian observations to the meridian for finding the latitude, and again the latitude is required in order to deduce the time from altitudes. An approximate latitude, such as results from the largest observed altitude about the meridian, will give the time near enough for the reduction to the meridian, and then the time may be computed rigorously with the exact latitude. Provision may be made for this revision by taking out the differences of the logarithms at each step of the first computation; but generally speaking, when the altitudes for time are taken near the prime vertical, as they ought to be, a small error in the latitude has so little effect on the hour angle, that the approximate latitude is near enough.

Determination of Greenwich Time astronomically.—1. There are two phenomena which are seen at the same moment from whatever part of the earth they are visible, namely, a lunar eclipse and the eclipses of Jupiter's satellites. The first was the only phenomenon from which longitudes were derived previous to the invention of telescopes, but it is not of frequent occurrence, and unfortunately cannot be noted very exactly. It has been proposed to measure equal quantities of the eclipse on each side of the middle, and formerly astronomers were very careful to note the moments when the umbra touched or covered well-defined spots. But at present, lunar eclipses are scarcely regarded, as there are many more accurate means of determining the longitude, and of more frequent occurrence; and lunar eclipses are of no value in the theory of the moon's motions. The eclipses of the satellites of Jupiter, especially of the first satellite, are much more common, and have been of great use in modern geography. The time at which the eclipses take place, that is, when the satellite, passing into the shadow of Jupiter, is lost (immerges), or passing out of the shadow, becomes visible (emerges), are set down in the 'Nautical Almanac' at the time they would be seen at Greenwich if visible. The observer at any other place notes when this phenomenon does actually happen at the place of observation, and the difference between the two times is the longitude of the place from Greenwich; east if the time of the eclipse is later than at Greenwich, and west if it be earlier. Unfortunately this method, so easy in practice, is by no means as accurate as it might at first sight appear. The theory of the satellites is scarcely to be considered as perfect, but this objection might be obviated by comparing corresponding observations, and might be very much diminished by correcting the predictions of the 'Nautical Almanac' by observations made at Greenwich, or any other well known place, about the same time. But the phenomenon is a gradual and not an instantaneous one, and the appearance or disappearance of the satellite varies greatly with the goodness of the telescope, the eye or mood of the observer, the atmosphere at the place of observation, &c., so that a longitude deduced from an eclipse of the first satellite may be considerably wide of the truth. With ordinary telescopes we believe that eclipses of the second satellite are more than twice as uncertain as the first, and that the third and fourth satellites are not worth observing for this purpose, being much inferior to good lunar distances. A large mass of eclipses of Jupiter's satellites made by the same telescope and the same observer, and where the immersions are nearly as numerous as the emersions, will however yield a satisfactory result. The aperture of the object-glass employed, and also the sight of the observer, should correspond as nearly as possible with the telescope and observer at Greenwich, or whatever place is adopted as a standard of comparison. It is not considered advisable to use a smaller telescope than an achromatic of 2¾ inches aperture for this purpose, or one larger than of 3½ aperture.

2. The time at Greenwich is most accurately determined by solar eclipses or occultations of fixed stars by the moon. The computations are rather long, but not very difficult or abstruse. The beginning and end of the solar eclipse should be observed; the latter is the better marked phenomenon, and if the eclipse be annular, the commencement and breaking up of the annulus. Recent observations have shown that these appearances are not instantaneous, and therefore that longitudes deduced from them are not free from uncertainty. The occultation of a fixed star by the moon is not liable to this objection; and when the star is bright, and both immersion and emersion can be carefully observed, the longitude from an occultation affords perhaps the best determination possible of the longitude between two distant places. Yet even here doubts may arise, at least in some cases. The star may be occulted too early by a lunar mountain, or disappear too late in a lunar valley. The occultation should be observed at both places, which is not often possible, and the star should pass not far from the centre of the moon. If the solar eclipse or the occultation be not observed at Greenwich, or at any well determined observatory, the data of the 'Nautical Almanac' must be corrected by the meridian observations of the moon about the time. The tables of the sun are at present nearly as perfect as observation can make them, but the moon may be out 15″, or even 20″, which might occasion an error of 30^{s} or 40^{s} in the deduced longitude, or from an eighth to a sixth of 1°. The solar eclipses, &c., with a map showing in what parts of the globe they are visible, are given in the 'Nautical Almanac,' and the occultations by the moon of all fixed stars to the sixth magnitude inclusive, visible at Greenwich, are also predicted to the nearest minute, with such a description of the relative situation of moon and star as will enable any one to observe them without difficulty. All possible occultations of fixed stars to the fifth magnitude inclusive, visible anywhere, are also set down in that valuable work, with the data necessary for determining whether they are visible at any specified place. We cannot press too earnestly on all persons interested in perfecting geography, the absolute necessity of learning to *observe* an occultation, and to take altitudes methodically with a circle or sextant. The computations may be made at home.

The transits of Mercury over the sun are rare, and the longitudes derivable from them not very accurate.

3. A good and now fashionable method of determining the longitude is by observing with a transit instrument the meridian passage of the moon's bright limb, and of stars which are near her parallel of declination. The 'Nautical Almanac' contains a list of the stars proper to be observed with the moon, and also the variations of the moon's R. A. in one hour of longitude, for computing the longitude.* When the place of observation is tolerably near Greenwich, the computation is very simple, that is, *if the transit is nearly in the meridian and the moon is observed all over the wires.* The error of the chronometer is taken from the neighbouring stars, and the transit of the moon corrected for this error, and for the rate, if sensible. If the place be to the east of Greenwich, the R. A. of the moon is less; if to the west, the R. A. is greater than at Greenwich. Taking the difference between the R. A. at the place and at Greenwich, and dividing by the variation in one hour of longitude, you have the longitude of the place E. or W. in hours and decimals of an hour. But this result requires correction when the corresponding observations at Greenwich, Cambridge, Edinburgh, &c., can be procured; for the R. A. of the moon may be erroneous more than $1^{s}\cdot0$ from the imperfection of the lunar tables. By using the R. A. of the moon and stars *observed* at Greenwich, the longitude will not be affected by the errors of the tables. It is pretty much the same thing, and at times more convenient, to let the former computation stand, and to compute the longitude of Greenwich, Cambridge, &c., from the observations respectively

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* There are tables for this purpose in Schumacher's 'Hülfstafeln,' and in many sets of tables.

* These data might perhaps be further extended with advantage. Suppose the R. A. of the moon's bright limb on the meridian of Greenwich to be m; on the meridian of any other place the longitude of which is required, m'; the longitude of the place to be l, + when west, and — east; then m' can be thus expressed; $m' = m + a\,l + b\,l^2 + c\,l^3 + d\,l^4$, where a, b, c, and d can be previously computed, l being in decimals of a day. The approximate value of l, from the first term, $= \frac{m'-m}{a}$. Substituting this value for l, let the sum of the other terms $= s$, then the exact longitude $= \frac{m'-m}{a} - \frac{s}{a}$.

made there, taking care to note the signs of the resulting longitudes. Then if the longitudes of the known and of the unknown place are both east or both west, the difference will be the true longitude of the unknown place, east or west of the known one. Some telescopes give a larger image of the moon than others, and its apparent diameter is affected by varying the aperture of the object-glass. The resulting errors in the longitude are got rid of by observing the second limb as often, if possible, as the first, and then, keeping the results separate, by taking a mean of the two. There is a mistaken notion among many observers, that there is no need to care for the position of the transit. Now any considerable error in the position of the transit does occasion an equivalent error in the longitude, and though it can be corrected, if there are data for determining the want of adjustment, this gives some trouble in the computation. It is so easy to place a transit very nearly in the meridian, and to adjust it in every respect, at least approximately, that there is no excuse for carelessness in this respect. The observer should always take the transits of a star near the pole, and of all Greenwich stars above and below the moon which pass about the time of her culmination, and it is proper to reverse the instrument on alternate nights. When the place of observation is very distant from Greenwich, it will be necessary, until the quantities a, b, c, d, mentioned in the note, be computed, to take a little more trouble. The approximate longitude is calculated as before, and then the R. A. of the moon's bright limb must be computed for the corresponding Greenwich time, from the R. A. of the moon for every hour; the moon's semi-diameter in R. A. must also be computed. We have found it on the whole most intelligible, and therefore most safe, to compute the R. A. of the moon's bright limb on two hypotheses of longitude, one the minute above and the other the minute below the approximate value. These results are to be corrected by the Greenwich or other observations for the error of the lunar tables, and then, by simple proportion, the correction is determined for one of the hypothetical longitudes. This is rather a long process, but it is strictly accurate, and the steps are intelligible as the computer proceeds. The method of determining the longitude by transits of the moon and stars is the best for places very distant in latitude or longitude, where the same occultations cannot be seen. It is nearly as good for the most distant as the nearest place, the variation of the error of the lunar tables being the only additional cause of inaccuracy, and the phenomenon presents itself very often. It does however require a very nice and well fixed instrument and a careful observer, as 1^s error in observing the R. A. of the moon will cause an error of nearly 30^s in the resulting longitude, or $\frac{1}{8}$ of a degree. A considerable mass of observations of both limbs corrected by corresponding observations will scarcely be more than 2^s or 3^s wrong.

4. But where a transit instrument cannot be carried, or cannot be used, as at sea, the longitude must be found *astronomically* by the distance of the moon from the sun, planets, or fixed stars, measured with a reflecting instrument. This apparent distance is reduced to the true distance, that is, such as it would be, seen from the centre of the earth, and as these distances are computed and set down in the 'Nautical Almanac' for every three hours Greenwich time, as they would be seen from the same place, the Greenwich time corresponding to the time of the observation can be calculated. But the time at the place is always supposed to be known from observation, and hence the difference gives the longitude. The longitude may be determined on shore by lunar observations, and, if a stand be used, with much greater accuracy than at sea. All ships and travellers ought to be well supplied with chronometers, that is, the means of keeping their Greenwich time when by observation they have got it, and then the result of the observation and computation is simply stated to be the error of the chronometer on Greenwich time. The chronometer, if the rate be pretty well known, continues to give the Greenwich time (the correction for error and rate being applied) for several days; and the longitude is found every day, by comparing the actual time at the place of observation with the Greenwich time at the same moment, given by the chronometer. We have spoken as if one chronometer alone were used, but it is mere folly to rely upon one or even two chronometers in a ship, or in important geographical researches.* These are to be compared from day to day, to ascertain that they are not suddenly altering their rates, and also whenever any astronomical observation is made which determines the Greenwich time (for that gives the error of each of the chronometers), or the time at the place. In reducing observed lunar distances to the true lunar distances, the altitudes of the sun and moon, or moon and stars at the time of observation are required, and at sea two observers are commonly set to measure these altitudes at the moment the lunar observer gives a signal that he has made the contact; indeed a fourth person is sometimes engaged in noting the chronometer. On shore this profusion of aids cannot always be obtained, nor are they at all wanted. If the time at the place and the latitude be known, the altitudes may be computed, or the observer may proceed thus: 1st, an altitude of the sun, planet, or star; 2ndly, an altitude of the moon's bright limb; 3rdly, three lunar distances; 4thly, a second altitude of the moon; and 5thly, a second altitude of the star or sun, noting the chronometer at each observation. He will then have the means, by simple proportion, of reducing the altitudes to what they would have been at the time of observing the lunar distances.

We should advise observers, who are properly furnished with chronometers, rather to make a large number of observations on a few favourable nights, than to take a few observations on many nights. By observing several lunar distances on both sides of the moon, and from all the stars and planets east and west given in the 'Nautical Almanac,' the errors of the instrument may be in a great measure eliminated, and the error of observation much diminished. It is evident that if two equal distances are taken, one east of the moon and the other west, then any error of the instrument, such as erroneous index error, want of parallelism in the glasses or telescope, excentricity, &c., would be the same in each, and therefore could be got rid of. In like manner, if two observations on the same side of the moon give different longitudes, it is clear that the instrument has some error which is *not* index error. On this subject we shall have occasion to speak again in treating of the sextant. The luni-solar observations are generally preferred by seamen (and they are perhaps the most satisfactory), partly perhaps because the altitude of the sun, by giving time at the place, is immediately applicable to the determination of the longitude. The longitude from lunar distances, however carefully taken, cannot be relied upon to very great nicety. With all appliances, a distance to 10", and a longitude to 20^s, or $\frac{1}{12}$th of a degree, can scarcely be considered as certain, and the errors of the lunar tables will not unfrequently double this error. At sea it would not be safe to rely on any series of lunar distances for a less quantity than 1^m of longitude, or $\frac{1}{4}$th of a degree, but this is quite sufficient for the purposes of navigation in open seas.

The computation of lunar distances is very easily performed by Thomson's tables, which are exceedingly convenient, and require only a little more extension. They are approximate, but near enough for the navigator and the traveller *en route*. As the last accuracy can only be given to the computations after the errors of the lunar tables are corrected, there is no need of much refinement in the previous work.

It has been proposed to determine the longitude on shore by taking altitudes of the moon with the mercurial horizon; and between and near the tropics the method may be a good one. In these low latitudes the motion of the moon in altitude is nearly vertical and very rapid, and this motion is doubled by observing the distance between the moon and its image seen by reflection. The bright edge of the moon is a good object in reflecting instruments. The calculation may be made thus: The time at the place must be most scrupulously determined, and the error and rate of the chronometer known, if possible, by equal altitudes of the sun on each side of noon and midnight. Then, the error of the chronometer being known at the place and time of observation, assume an approximate value of the longitude, and determine the Greenwich time, the R. A. and declination of the moon, and its apparent diameter and parallax. Each altitude of the moon will, when properly reduced, give an error of the chronometer, which, if the assumed longitude be correct, will agree with the error obtained by the sun or stars. If there be a difference, a second longitude may be assumed, and thus, as has been shown in speaking of transits of the moon, the terms may be obtained from which, by a simple proportion, the true longitude can be deduced. It is not improbable that the doubling the motion of the moon in observing by reflection, and the sharpness of the images, may make up for the error committed in ascertaining and keeping the time; but of this the observer must be the judge.

Determination of Greenwich Time by Chronometers.—Hitherto the Greenwich time has been extracted from astronomical phenomena, but where the distance is not great, the time may be brought from Greenwich by chronometers. Suppose, for instance, the longitude of Madeira were required: then, having ascertained the errors and rates of several good chronometers at Greenwich, they are carried to Madeira, and their errors on the meridian of Madeira, and their rates, determined there. The Greenwich time is known from each chronometer, supposing the rate during the voyage to be the mean of the rates before and after, and thus each chronometer gives a longitude of Madeira, and the mean of the whole is taken. The voyage back to Greenwich, in like manner, with the errors and rates on arriving at Greenwich, furnish a second longitude; and if the motion at sea has any tendency to alter the rates, this cause will affect the first determination with a certain error, while it affects the second determination with exactly the same error, but in a different sense. If it increases the difference of longitude one way, it diminishes it the other way. By a mean of several such voyages the difference of longitude of places within a week or perhaps a fortnight's journey may be ascertained with considerable exactness. There are some precautions to be adopted in determining longitudes chronometrically, which ought not to be neglected. It is well known that two observers will sometimes differ several tenths of a second from each other in getting the time at the same place and with the same instrument. Now this *personal equation*, if it exist between the observers at the two places, will affect the longitude by exactly its amount: hence the observers should be reversed for half the time of the experiment, if possible, or their *relative personal equation* found by comparison with each other, or at least with a third person. The accuracy of a chronometrical longitude depends on the distance in time between the places compared and the smoothness of the conveyance. It is decidedly the best mode where the distances do not exceed three or four days' journey, and where there are good carriage-roads or steam-boats. At sea, for voyages of moderate length, the Greenwich time may be taken almost entirely from chronometers; and if the number be considerable, and the watches good, there is little occasion for lunar distances, except for the greater caution, and to be assured against any accident affecting all the timekeepers the same way.

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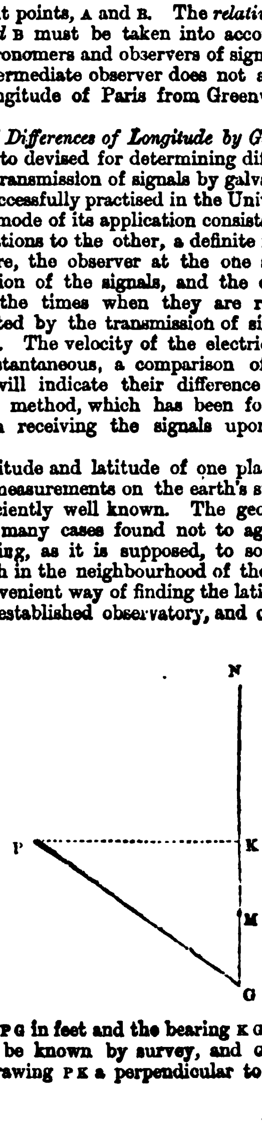
* In the first place chronometers are liable to accidents, and secondly, to change their rates, and that sometimes by jumps. With two chronometers evidence is given of error by their discrepance, and with three, the faulty chronometer may be detected. The best two-day box-chronometers may be bought for forty guineas, and the best gold and silver pocket-chronometers for forty and thirty guineas respectively. There is an idle opinion that chronometers are not good pocket-watches. They are perhaps a little more liable to injury *when let fall*, than other watches, on account of the heavy compensated balance, but after wearing chronometers for years without any particular care, we believe that three good pocket-chronometers, not larger than common watches, will keep the time for a month, as well as it can be got by lunar distance.

Determination of Differences of Longitude by Rockets.—Another mode of ascertaining differences of longitude is that of conveying the time from one point to another by fire-signals or rockets. Thus, if a rocket is fired from a station between two observatories, and the explosion noted *in the time proper to each place*, the difference between the times will be the difference of longitude. A chain of such signals may be extended a considerable distance thus:—Let the two points to be connected be A and B, and let an observer with a chronometer be placed at a, and others with rockets at α, β, thus: A, α, a, β, B. Then the observers at A and B note the rockets from α and β in times of their respective observatories. The person stationed at a notes by his chronometer the rockets at α and β (suppose β at 10 minutes after α), and as he observes α at the same physical moment with A, A would see β, if it were visible, just 10 minutes later than he does actually see α, and therefore the explosion of β is known in time proper to A's observatory; but it is also seen by B at the same moment in his time, and therefore the difference of longitude is obtained. In like manner, any number of intermediate stations of observers and rockets may be interpolated between two distant points, A and B. The *relative personal equation of the observer at* A *and* B must be taken into account [EQUATION, PERSONAL] both as astronomers and observers of signals; but the personal equation of the intermediate observer does not affect the observation. In this way the longitude of Paris from Greenwich was determined. ('Phil. Trans.')

Determination of Differences of Longitude by Galvanic Signals.—The best method hitherto devised for determining differences of longitude, is founded on the transmission of signals by galvanic electricity. This method was first successfully practised in the United States of America. The most obvious mode of its application consists in despatching from one of the two stations to the other, a definite number of signals by the telegraphic wire, the observer at the one station recording the times of transmission of the signals, and the observer at the other station recording the times when they are received. The operation is then repeated by the transmission of signals from the second station to the first. The velocity of the electric fluid being supposed to be sensibly instantaneous, a comparison of the local times at the two stations will indicate their difference of longitude. The application of this method, which has been found to give the best results, consists in receiving the signals upon Saxton's recording apparatus.

Finally, the longitude and latitude of one place from another may be determined by measurements on the earth's surface, if the figure of the earth be sufficiently well known. The geodesical latitudes and longitudes are in many cases found not to agree with those found astronomically, owing, as it is supposed, to some variations in the density of the earth in the neighbourhood of the place of observation. It is however a convenient way of finding the latitude and longitude of points near a well-established observatory, and connected by trigonometrical survey.



Let the distance PG in feet and the bearing KGP of the point P from the observatory G be known by survey, and GN be an arc of the meridian. Then drawing PK a perpendicular to GN, PK=PG×sin of PGK and GK=PG×cos PGK, when PK and GK are known, in feet. Find the value of $\frac{1}{2}$ KG in seconds of latitude approximately by supposing 1″ to be=100·8 feet, and add or subtract this, as the case may be, to the latitude of G, which will give the latitude of M, the middle point; call this λ. Then the value in English feet of a degree of latitude at M is

$$362747{\cdot}7+\text{number the logarithm of which}=\left\{\begin{array}{l}3{\cdot}5634881\\+2\log\sin\lambda\end{array}\right.$$

and the value of a degree of longitude at the same parallel in English feet=

$$\text{number, log}=\left\{\begin{array}{l}5{\cdot}5625161\\+\log\cos\lambda\end{array}\right\}+\text{number, log}=\left\{\begin{array}{l}3{\cdot}0863668\\+\log\cos\lambda\\+2\log\sin\lambda\end{array}\right.$$

With these values of a degree of latitude and longitude the distances GK and PK are readily converted into arcs of latitude and longitude.

On this subject the reader may consult the article GEODESY, and the 'Encyclopædia Metropolitana,' art. 'Figure of the Earth.'

The solution of the problems assumed to be known in the foregoing article may be found in all treatises on astronomy and in most collections of tables of navigation. We have recommended Thomson's 'Tables' as very convenient, and sufficiently accurate for the traveller and navigator, but any tables and methods which a man has become accustomed to will do. It would require too much space to give reasons and explanations for the opinions here advanced, but we will give two or three recommendations which few observers will regret to have followed. The first is to make, when practicable, large masses of careful and unhurried observations, and especially to observe the rules given above for nullifying instrumental error, by making such observations that a given error will have contrary effects in the result. Secondly, to be very careful in selecting their instruments and their timekeepers, which should come from good makers, and be carefully tried before starting, especially at such temperatures as the traveller may expect to meet with. A chronometer which is excellent for a polar expedition may be an indifferent watch on the Tigris or in the interior of Africa, and *vice versâ*. For any overland expedition three pocket chronometers should at least be taken, and the number must be increased according to the length, the difficulty, and the importance of the journey, and a liberal allowance made for stoppages, changes of rate, accidents, &c.: a belt of half a dozen chronometers would scarcely be felt to be an inconvenience. Lastly, if the traveller's object be chiefly that of determining exact positions, he should be careful to determine the longitudes of all his principal points by solar eclipses or occultations of fixed stars by the moon, if he cannot carry and fix a transit. At these points he should determine the rates of his chronometers for a new departure, and determine as much of the country as circumstances will allow by journeys of ten days or a fortnight, returning to the same place. When the principal points are well fixed (we speak of longitudes, for good latitudes may be got with almost any instrument, or by any person), the chronometers will fix every halting-place where the time is observed, and this may be got in a few minutes any fine night or morning or afternoon; and then the itineraries, compass bearings, marches, &c., and all the loose information on which too much of our geography is founded, will furnish valuable details in the proper place. The necessary apparatus is not very expensive or cumbrous, and with a little practice can be managed by a moderately intelligent and methodical person.

LOOM. [WEAVING.]

LOPHINE ($C_{42}H_{16}N_2$) is one of the bases derived from the oil of bitter almonds. It is formed when benzoline is distilled. Ammonia is given off, and lophine is left undissolved. It is soluble in alcohol with acids, and precipitated again by ammonia. It occurs in the form of fine silky crystals, and forms salts with acids, which are however not very stable.

LORD ADVOCATE OF SCOTLAND. This is the peculiar appellation of the senior standing counsel for the crown in Scotland. The regular series of such officers cannot be carried to an earlier date than the end of the 15th century. Previous to that time, indictments seem to have been under the superintendence of the clerk of court, or justice clerk [JUSTICE CLERK]; and for prosecutions before the parliament, we find sometimes the chancellor, sometimes the clerk-register, and at other times a special counsel for the crown.

The earliest standing "Advocate," and with whom the series properly begins, was Sir John de Ros of Mountgreenan, in the county of Ayr, an individual well known both in the politics and literature of his time, and one of the poets commemorated by Dunbar. When the Court of Session was erected, Sir Adam Otterburn of Auldhame was king's advocate, and was not only privileged to plead within the bar, but actually nominated one of the judges of the court. It was from this circumstance he acquired the style of Lord Advocate (Pitcairn's *Criminal Trials*, Stat. 1587, c. 115.). In 1610, he had the additional style of "Right Honourable." (Act of Sederunt, 17th Nov., 1610.) It was, however, in the time of Sir Thomas Hope (founder of the noble family of Hopetoun, and others) that the office acquired the vast political importance which has in modern times belonged to it. This arose not less from the subtle and ambitious character of that famous person, than from the circumstance of the king's removal to the throne of

England, and the consequent remoteness of Scotland from the immediate seat of government.

It is difficult to define the powers and duties of the lord advocate; they are said to be indefinable. The most prominent however is that of public prosecutor; and in this capacity he has, besides the solicitor-general, four standing deputies of his own appointment, who retire with him on a change of ministry. These deputies assist him in the Court of Justiciary, and are despatched by him to the several circuits of that court to prosecute indictments there. He has also a deputy in the Court of Exchequer; and a deputy or occasional substitute to conduct prosecutions before the sheriff of Edinburgh, or other county courts. Every county court has indeed a "procurator fiscal," whose duty it is to sue on behalf of the crown in his county; but that officer is not yet placed on a proper footing, being neither of the bar, nor named by the crown or the lord advocate.

LORD-KEEPER (*Custos magni Sigilli*), an ancient officer of the crown, who had the custody of the king's great seal, with authority to affix it to public documents, some of the most important of which can only be authenticated in this formal manner.

Until the reign of Henry III. the office of keeper of the great seal appears to have been distinct from that of chancellor, and generally subordinate to it. The chancellor, as a high judicial officer, was sworn at his entrance upon his duties, but the functions of the keeper being considered as chiefly ministerial, no oath appears to have been required from him. The chancellor was often elected by the baronage parliament, or great council of the nation, but the custody of the great seal was under the control of the king. The ancient entries respecting the appointment of the chancellor generally are—A. B. Cancellarius (or in Cancellarium) Angliæ electus, or a baronagio, or in pleno parliamento, or per regem et parliamentum, constitutus est. Records of the reign of Henry I. and John show that both offices were held simultaneously by different persons under those princes. Sometimes the offices were united in one individual, who was thus both judge and minister. In 11 Henry III., Ralph Nevill was appointed by parliament chancellor for life; and two years afterwards he received the custody of the great seal from the king. In 22 Henry III. the great seal was forcibly taken from Nevill by the king, who delivered it to two persons, Geoffrey the Templar and John Lexington; but as Nevill could not be deprived of his judicial authority by the crown, he continued to hold the office of chancellor until his death. But the great seal was under the control of the chancellor; and when Henry III. demanded it from the Bishop of Chester, his chancellor, he answered, that having received the seal by the common council of the realm, he could not resign it to any one without the like common consent. It was matter of complaint against Henry III. that in 1261 he appointed Walter de Merton to be chancellor, "inconsulto baronagio," or without the consent of the baronage. In the following year he appears to have removed Hugh le Despencer the chief-justice, and Nicholas de Ely the chancellor, appointed by the barons.

Edward I. took the great seal with him into Flanders, and afterwards into Gascony, leaving his chancellor in England with a temporary seal: and in 6 Edward I. the Bishop of Bath and Wells, the chancellor, on going abroad left the great seal in the custody of Sir John de Kerby, with an injunction to despatch the business of the chancellery in his absence. The chancellor cannot now make a deputy, or, as he was formerly called, a lieutenant. In 16 Edward I., Ayremin, master of the rolls, and his companions, were keepers of the great seal; Burnell, bishop of Bath and Wells, being at the same time chancellor. Among the restrictions imposed on Edward II. by the ordeinours elected by the barons and commons in parliament, was one that the king should appoint the chancellor and certain other great officers by the advice and assent of his baronage, and in parliament. This seems to have been the last interference with the royal authority over the appointment of chancellor until the time of the Long Parliament. In the more vigorous reign of Edward III. we find by the parliament roll that in 1343 the commons prayed that no alien might be made chancellor, but the king answered, that he could appoint whom he would. Henry V. had two great seals, one of gold, which he delivered to the Bishop of Durham, making him *lord chancellor* of England, and another of silver, which he delivered to the bishop of London to *keep*. The statute 31 Henry VIII., c. 10, assigned the same rank to the lord chancellor and the lord-keeper, giving to the person holding the one office or the other precedence over all lay peers, except those of the blood royal; and in 5 Elizabeth, c. 18, Sir Nicolas Bacon, lord-keeper, procured an Act which, after reciting that some question had *of late* arisen whether like place, authority, and power belonged to the office of lord-keeper of the great seal of England, as belonged to the lord-chancellor of England, declares that the keeper of the great seal has always had, used, and executed the same place, authority, preeminence, jurisdiction, execution of laws, and all other customs, commodities, and advantages as the lord-chancellor.

Notwithstanding these two statutes the appointment of lord-keeper appears not to have stood so high in the estimation of the public as that of chancellor; and the great seal has been generally delivered with the latter title.

Upon the rupture between Charles I. and his parliament the king took the great seal to Oxford, upon which a new seal was ordered to be made by the parliament. This measure was the subject of severe reproaches from the royalists; though unless the parliament were prepared to submit unconditionally to the king, it is difficult to say how any other course could have been adopted.

(Matth. Paris; *Parliament Rolls*; Coke's 4th *Inst.*; Bohun's *Cursus Cancell.*)

The power and duties of the lord-keeper, as identified with the chancellor, have already been stated. [CHANCELLOR; CHANCERY.]

LORD-LIEUTENANT. It was formerly usual for the crown, from time to time, to issue commissions of array, requiring certain experienced persons to muster and array the inhabitants of the counties to which such commissioners were sent. They were directed to put into military order those who were capable of performing military service, and to distrain such as were not qualified to serve, but were possessed of real or personal property, to furnish armour to their more vigorous countrymen; and they were to erect beacons where necessary. The form of these commissions, after much complaint, was settled by statute, and may be seen at length in the Parliament-rolls of 5 Hen. IV., 1403-4.

In the 16th century these commissions appear to have given place to commissions of lieutenancy, by which nearly the same powers were conferred on certain persons as standing representatives of the crown. In 1545 a commission "de arraiatione et capitaneo generali contra Francos" issued to the duke of Norfolk, constituting him the king's *lieutenant*, and captain-general of all captains, vice-captains, men-at-arms, armed men, archers, and all others retained or to be retained against the French, in the counties of Essex, Suffolk, Norfolk, Hertford, Cambridge, Huntingdon, Lincoln, Rutland, Warwick, Northampton, Leicester, and Bedford. A similar commission issued to the Duke of Suffolk for the counties of Kent, Sussex, Surrey, Hants, Wilts, Berks, Oxford, Middlesex, Bucks, Worcester, and Hereford, and London; and to John Russell, knight, Lord Russell, keeper of the privy seal, for the counties of Dorset, Somerset, Devon, Cornwall, and Gloucester. (Rymer.) These officers are however spoken of by Camden, in the reign of Elizabeth, as extraordinary magistrates, constituted only in times of difficulty and danger, which was the case with commissioners of array, as appears from the recitals in their commission.

The right of the crown to issue commissions of lieutenancy was denied by the Long Parliament, and formed a proximate cause of the rupture between Charles I. and his subjects. Upon the Restoration the right of the crown to issue such commissions was established by a declaratory Act, 14 Charles II., cap. 3.

The authorities and duties of the lord-lieutenant and of his temporary vice-lieutenants, and of his permanent deputy-lieutenants, have with reference to military affairs been regulated by the Militia Acts. [MILITIA.] The lord-lieutenant, however, nominates to the Lord Chancellor, all the justices of the peace for the county of which he is lieutenant.

LORD OF MISRULE, the master of the revels at Christmas in any nobleman's or other great house. "First in the feast at Christmas," says Stowe, 'Survey of London,' "there was in the king's house, wheresoever he was lodged, a Lord of Misrule, or master of merry disports, and the like had ye in the house of every nobleman of honour or good worship, were he spiritual or temporal; amongst the which the mayor of London, and either of the sheriffs, had their several Lords of Misrule, ever contending, without quarrel or offence, who should make the rarest pastimes to delight the beholders. These lords, beginning their rule on Alhallow-eve, continued the same till the morrow after the Feast of Purification, commonly called Candlemas-day: in all which space there were fine and subtle disguisings, masks, and mummeries, with playing at cards for counters, nailes, and points in every house, more for pastime than for gain."

This lord of Misrule, or revel-master, was sometimes termed a Christmas prince. Warton, in his 'History of English Poetry,' tells us that in an original draught of the statutes of Trinity College at Cambridge, founded in 1546, one of the chapters is entitled, 'De præfecto Ludorum, qui *Imperator* dicitur,' under whose direction and authority Latin comedies and tragedies are to be exhibited in the hall at Christmas; as also "sex spectacula," or as many dialogues. With regard to the peculiar business and office of Imperator, it is ordered that one of the Masters of Arts shall be placed over the juniors every Christmas, for the regulation of their games and diversions at that season of festivity. His sovereignty was to last during the twelve days of Christmas, and he was to exercise the same power on Candlemas-day. His fee was forty shillings. In an audit-book of Trinity College in Oxford, for the year 1559, Mr. Warton found a disbursement "pro prandio *Principis Natalicii*." A Christmas prince or lord of misrule, he adds, corresponding to the imperator at Cambridge, was a common temporary magistrate in the colleges at Oxford. The law societies of London had similar commemorations, and in 1635, the expenses of the Master of the Revels in the Middle Temple amounted to 2000*l.*, paid from his own purse, and when he was deposed, or his term of office had expired, he was knighted by the king. After 1640 we hear nothing of the Lord of Misrule in England.

In Scotland, where the Reformation took a more severe and gloomy turn than in England, the "Abbot of Unreason," as he was there called, and other festive characters, were suppressed by the legislature as early as 1555. At Rodez, the capital of the province of Rovergne in France, previous to the Revolution, they had an "Abbé de la Malgouverné," who corresponded exactly with our Lord of Misrule.

LORDS, HOUSE OF, one of the constituent parts of the Parliament of the United Kingdom. [PARLIAMENT.] The other is the House of Commons.

The persons who sit in the House of Lords are the Lords Spiritual and Lords Temporal.

Before the Reformation, when the monastic establishments which abounded in England were suppressed, the superiors of many of them, under the names of abbots and priors, sat as Lords Spiritual in this assembly. In those times the Lords Spiritual equalled, if they did not outnumber, the Lords Temporal who sat at any given time in Parliament; though now they form only about one-thirteenth of the persons composing this assembly. Six more bishops were added when the abbots and priors were removed.

The Lords Temporal are all the peers of England, being of full age, and not incapacitated by mental imbecility; sixteen representative peers of the Scottish peerage, and twenty-eight representatives of the Irish peerage. The number of the Scotch and Irish representative peers is fixed by the acts of union with Scotland and Ireland in 1707 and 1800 respectively; but the number of peers of England is perpetually varying, and depends upon the casualties of minorities, and on the will of the sovereign, who can make any man a peer. In June, 1860, it consisted of 3 princes of the blood royal, 3 archbishops (one being an Irish representative), 20 dukes, 21 marquises, 111 earls, 22 viscounts, 24 English bishops, and 3 representative Irish bishops, and 214 barons, besides the Scotch and Irish representative peers.

The component parts of this assembly may be thus classified:— 1. Persons sitting there in respect of offices held by them. Such are the spiritual lords of England. 2. Persons who sit in right of inheritance of a dignity of peerage. 3. Persons who have been created peers. 4. Hereditary peers of Scotland (for there can be no creation of peers of that part of the United Kingdom) elected by the whole body of the Scottish peerage to represent them in parliament, at the beginning of every parliament. 5. Hereditary or created peers of Ireland, elected by the whole body of the Irish peerage; they sit for life, and vacancies are supplied as they occur. Irish peerages can be created in the proportion of one for every three becoming extinct. And 6. Spiritual lords of Ireland, who sit in turns according to a cycle established by 3 Will. IV. c. 37. The great body of the house however consists of hereditary Lords Temporal of England, under the several denominations of dukes, marquises, earls, viscounts, and barons. Each of the individuals of these ranks has an equal vote with the rest; but they sit in the house in classes, and according to their precedency.

The only material changes which have been made in the constitution of this assembly in the long period of its existence have been: 1. The supposed limitation of the right of all holding lands in chief of the crown to sit therein, by king Henry III. after the battle of Evesham. 2. The removal from it of representatives of the counties, cities, and boroughs, who are supposed to have formerly sat with the lords, and the placing them in a distinct assembly, called the House of Commons. 3. The reduction in the number of the Lords Spiritual, by the suppression of the monastic establishments. 4. The introduction of the Scottish representative peers. And 5. The introduction of the Irish bishops and the Irish representative peers.

This house may be traced to the very beginning of anything like an English constitution. It is in fact the *magnum concilium* of the early chronicles. The bishops are sometimes said to sit there in virtue of baronies annexed to their respective offices; but it is questionable whether baronies are attached to the bishoprics of the new creation by Henry VIII.; and at best it is but a legal fiction, it being evident from the whole course of history that the bishops formed, as such, a constituent part of such assemblies in the Saxon times, and were, as such, among the chief advisers of the king. One of the last acts of King Charles I., before he finally left London and disconnected himself from the Parliament, was to give the royal assent to a bill for removing the bishops from Parliament. The bishops were restored after the return of Charles II., 1660.

A question has been raised whether, as the Lords Spiritual and the Lords Temporal, though sitting together, form two distinct *estates* of the realm, the concurrence of both is not requisite in any determination of this house, just as the consent of the two houses of Parliament is necessary to every determination of parliament. But it is now understood that the Lords Spiritual and Lords Temporal are one body, whose joint will is to be collected by the gross majority of voices: and statutes have been made in the absence of all the Spiritual Lords.

The House of Lords has two distinct functions: the legislative and the judicial.

In its legislative character, every new law, and every change in the existing law, must have the consent of a majority of this house, as well as of a majority of the House of Commons.

In its judicial character, it is a court for the trial—1. Of criminal cases on impeachment by the House of Commons; 2. Of peers, on indictments found by a grand jury; 3. For the hearing and determining of appeals from decisions of the Court of Chancery: 4. For the hearing and determining of appeals on writs of error to reverse judgments of the Court of Exchequer Chamber (which is itself a court of appeal from the courts of Common Law); and 5. In hearing and determining appeals from the supreme courts in Ireland and Scotland. The House can require the attendance of the judges of the superior courts of law, to assist it in the discharge of its duties; which is sometimes done.

A few points in which the House of Lords differs from the lower house of Parliament remain to be noticed. In the chair of the house sits the lord high chancellor of England. When the king goes to Parliament he takes the throne in the House of Lords, and the Commons are summoned to attend him there to receive the communication of his will and pleasure. The royal assent to bills, whether given by the sovereign, in person, or by a commission appointed by the king or queen, is given in the House of Lords. All bills which affect the rights and dignities of the peerage must originate in that house. The members of the House of Lords have a right of voting on any measure before the house by proxy, but the proxy must be a member of the house; and, lastly, they have the privilege of entering on the journals of the house their dissent from any measure which has received the sanction of the majority, with the reasons for that dissent. This is called their protest. For further information see PARLIAMENT.

LORDSHIP. [LEET.]

LOTIONS, or washes, termed also epithems, and when intended for the eye, collyria, or eye-washes, are either mixtures of different ingredients, or solutions of various medicinal substances, in water or other menstrua, designed for external application. If the object be to reduce the temperature of a part, they are generally formed of spirituous or other volatile principles, which by their evaporation occasion cold (and such must be applied by means of a very thin single layer of linen); or of saline bodies, which at the moment of their solution cause a reduced temperature, and which should be applied immediately after being mixed, and frequently renewed. Others are composed of stimulating substances, and are intended to impart power to indolent tumours or ulcers, while a different set are designed to allay pain, and are composed of sedative or narcotic principles.

Many of the nostrums sold under the name of lotions are solutions of very active ingredients, and their application is often productive of very serious effects.

LOTTERIES have been encouraged by some states for the purpose of raising a revenue. The general plan has been for the government to sell a certain number of tickets or chances, and to distribute by lot a part of the money thus collected as prizes among a comparatively small number of the purchasers. Lotteries are games of chance, the aggregate number of players in which are sure to lose a part of their venture. During the period in which the English state lotteries were carried on by Act of Parliament, it was the plan to distribute in prizes of different magnitudes an amount equal to 10*l.* for each ticket or chance that was issued, and the profit to the state consisted of the sum beyond that rate which contractors were willing to give for the privilege of selling to the public the tickets or shares of tickets, which for that purpose they might divide into halves, quarters, eighths, and sixteenths of tickets. The price paid by the contractors for this privilege varied with circumstances, but was usually about six or seven pounds per ticket beyond the amount repaid in prizes, while the price charged by the contractors to the public was generally four or five pounds per ticket beyond that paid to the government; and more than this rate of advance was always required when the tickets were divided into shares, the smaller shares being charged more in proportion than the larger.

The earliest English lottery of which there is any record was in 1569, when 40,000 chances were sold at ten shillings each: the prizes consisted of articles of plate, and the profit was employed for the repair of certain harbours. In the course of the following century the spirit of gambling appears to have materially increased in this direction, for *private* lotteries were, early in the reign of Queen Anne, suppressed "as public nuisances." In the early period of the history of the National Debt of England, it was usual to pay the prizes in the state lotteries in the form of terminable annuities. In 1694 a loan of a million was raised by the sale of lottery tickets at 10*l.* per ticket, the prizes in which were funded at the rate of 14 per cent. for sixteen years certain. In 1746 a loan of three millions was raised on 4 per cent. annuities, and a lottery of 50,000 tickets at 10*l.* each; and in the following year one million was raised by the sale of 100,000 tickets, the prizes in which were funded in perpetual annuities at the rate of 4 per cent. per annum. Probably the last occasion on which the taste for gambling was thus encouraged was in 1780, when every subscriber of 1000*l.* towards a loan of twelve millions at 4 per cent. received a bonus of four lottery tickets, the value of each of which was 10*l.*

In 1778 an Act was passed obliging every person who kept a lottery-office to take out a yearly licence, and to pay 50*l.* for the same, a measure which reduced the number of lottery-offices from 400 to 51.

By limiting the subdivision of chances to the sixteenth of a ticket as the minimum, it was intended to prevent the labouring population from risking their earnings, but this limitation was extensively and easily evaded by means which aggravated the evil, the keepers of these illegal offices (commonly known as "little goes") and insurance offices requiring extra profits to cover the chances of detection and punishment. All the efforts of the police were ineffectual for the suppression of these illegal proceedings, and for many years a growing repugnance was in consequence manifested in parliament to this method of raising any part of the public revenue. At length, in 1823, the last Act that was sanctioned by parliament for the sale of lottery tickets contained provisions for putting down all private lotteries, and for rendering illegal the sale, in this kingdom, of all tickets or shares of tickets in any foreign lottery, which latter provision is, however, to this day, extensively evaded.

The system of state lotteries was very long carried on by the French government, and was the cause of still greater demoralisation than in England. State lotteries have been abolished in France. Lotteries for the purpose of raising money for state purposes are still carried on in the Austrian dominions, in several of the smaller German states, and by the government of the Pope. The issuing or dealing in tickets for foreign lotteries in the United Kingdom is punishable as a misdemeanour.

Lotteries have been very common in the United States, and have been sanctioned by the several states, not so much as a means of raising money for state purposes, as with the view of encouraging, as they supposed, many useful objects which could only be effected by raising at once a large sum of money, such as canals, the establishment of schools, and even the publication of a book. The numerous frauds practised in lottery schemes in the United States have perhaps done more to open the eyes of the people to the mischief resulting from them than any investigation into the true principles of lotteries. A distinguished American lawyer, who figured in the New York State Convention nearly fifty years ago, declared that though "he was no friend to lotteries, he could not admit that they were *per se* criminal or immoral, when authorised by law. If they were nuisances, it was in the manner in which they were managed. In England, if not in France, there were lotteries annually instituted by government, and it was considered a fair way to reach the pockets of misers and persons disposed to dissipate their funds. The American Congress of 1776 instituted a national lottery, and perhaps no body of men ever surpassed them in intelligence and virtue." These remarks are merely quoted in order to show what a man of high character in America for integrity and knowledge thought of lotteries. The opinions which he expressed were at that time shared by a great number, and lotteries are still common in the United States, as the advertisements in their papers show.

The lotteries called Art-Unions are noticed under Art-Unions.

LOUIS, or LOUIS D'OR, a gold coin in the old system of France, first struck under Louis XIII., in 1641. Kelly says, "Louis d'ors coined before 1726, which passed then for 20 livres, were coined at the rate of 36¼ per French mark of gold, 22 carats fine; the remedy in the weight was 14 grains per mark, and the remedy in the alloy one-fourth of a carat. These ceased to be a legal coin in France as far back as 1726; but they still continued to circulate through many parts of Germany and Switzerland, where they had a fixed value, and were known by the name of the old Louis d'ors." Upon the return of the Bourbon family, in 1814, the twenty-franc pieces struck by Louis XVIII., in imitation of the Napoleons, received the name of Louis, or Louis d'or; a designation which is likewise given occasionally to the same coin struck by king Louis Philippe, but which are more ordinarily called twenty-franc pieces. Both have been discontinued, and replaced by the Napoleon.

The old ecus, coined before 1726, were called Louis blancs, and Louis d'Argent.

LOXODROMIC SPIRAL (*λοξός*, oblique, *δρόμος*, course), the curve on which a ship sails when her course is always on one point of the compass. It is called in English works the Rhumb Line.

LUCERN (*Medicago sativa*), a plant of the Linnæan class Diadelphia and order Decandria, with a papilionaceous flower, and of the natural family of the Leguminosæ. There are many species of the *Medicago*, of which one is super-eminent as an artificial grass in temperate climates, and a most valuable plant for feeding cattle. It was in high repute among the ancients. The authors *De Re Rustica* speak of it with enthusiasm, and all over the continent of Europe, wherever husbandry has made any progress, it is in high reputation. Lucern is a plant which will not bear extreme frost nor superabundant moisture, and its cultivation is therefore restricted to mild climates and dry soils; but, where it thrives, its growth is rapid and luxuriant. In good deep loams lucern is the most profitable of all green crops; when properly managed, the quantity of cattle which can be kept in good condition on an acre of lucern, during the whole season, exceeds belief. It is no sooner mown than it pushes out fresh shoots, and wonderful as the growth of clover sometimes is in a field which has been lately mown, that of lucern is far more rapid. Where a few tufts of lucern happen to be, they will rise a foot above the surface, while the grass and clover, which were mown at the same time, are only a very few inches high.

Lucern, sown in a soil suited to it, will last for many years, shooting its roots downwards for nourishment till they are altogether out of the reach of drought. In the driest and most sultry weather, when every blade of grass droops for want of moisture, lucern holds up its stem, fresh and green as in a genial spring. The only enemies of this plant are a wet subsoil and a foul surface. The first is often incurable; be avoided by good cultivation.

It is useless to sow lucern on very poor sands or gravel, or on wet clays. The best and deepest loam must be chosen, rather light than heavy, but with a good portion of vegetable earth equally dispersed through it. If the ground has been trenched, so much the better; and if the surface is covered with some inferior earth from the subsoil, it will be no detriment to the crop, for it will prevent grass and weeds from springing up, and save much weeding. The lucern will soon strike down below it. It is not a bad practice to cover the lucern-field with a coat of coal-ashes or poor sand, merely to keep down the weeds, where this can easily be done.

The soil in which it is intended to sow lucern-seed should be well prepared. It should be highly manured for the two or three preceding crops, and deeply ploughed if not trenched. It should be perfectly clean, and for this purpose two successive crops of turnips are most effectual. The turnips should be fed off with sheep. In the month of March, the land having been ploughed flat and well harrowed, a very small quantity of barley, not above a bushel to the acre, may be sown, or rather drilled on the ground, and at the same time from 30 to 40 lbs. of lucern-seed sown broad-cast, and both harrowed in and lightly rolled. If the land will not bear to be laid flat without water-furrows, it will be useless to sow lucern in it.

As the crop comes up it must be carefully weeded; no expense must be spared to do this effectually, for success depends upon it. When the barley is reaped, the stubble, which will probably be strong, should be pulled up by the hand-hoe, or by harrowing, if the plants of lucern be strong, and, at all events, the ground must be cleared of weeds. It must not be fed off with sheep; they would bite too near the crown. Lucern should always be cut as soon as the flower is formed. If it is kept clear of weeds the first year, there will be little difficulty with it afterwards, when the roots have become strong. The second year the lucern will be fit to cut very early, and in a favourable season it may be cut four or five times. After each cutting it is useful to draw heavy harrows over the land, or an instrument made on purpose resembling harrows, the teeth of which are flat, and cut the soil like small coulters. It will not injure the plants, even if it divide the crown of the root, but it will destroy grass and weeds. Liquid manure, which consists of the urine of cattle and drainings of dunghills, is often spread over the lucern immediately after it has been mown, and much invigorates the next growth; but if the land is rich to a good depth, this is scarcely necessary. The lucern will grow and thrive from seven to twelve years, when it will begin to wear out, and, in spite of weeding, the grass will get the upper hand of it. It should then be ploughed up, all the roots carefully collected and laid in a heap with dung and lime to rot, and a course of regular tillage should succeed. The same land should not be sown with lucern again in less than ten or twelve years, after a regular course of cropping and manuring.

Cattle thrive upon lucern. Horses also work well upon it. Cows give plenty of good milk when fed with it. In spring it is apt to purge cattle, which, with a little attention, is not unhealthy for them. If it is given to them in too great quantities, or moist with dew, they run the risk of being hoven. These inconveniences are avoided by giving it sparingly at first, and always keeping it twenty-four hours after it is cut, during which time it undergoes an incipient fermentation, and the juice is partially evaporated; instead of being less nutritive in this state, it is rather more so.

An acre of good lucern will keep four or five horses from May to October, when cut just as the flower opens. If it should get too forward, and there be more than the horses can consume, it should be made into hay; but this is not the most profitable way of using it, and the plant, being very succulent, takes a long time in drying. The rain also is very injurious to it in a half-dry state; for the stem is readily soaked with moisture, which is slow in evaporating. The produce in hay, when well made, is very considerable, being often double the weight of a good crop of clover hay.

Many authors recommend drilling the seed of lucern in wide rows, and hoeing the intervals after each cutting. This is the best way with a small patch in a garden, and when only a little is cut every day; but in a field of some extent, the lucern, when once well established and preserved free from weeds by hand-weeding the first year, will keep all weeds down afterwards, and the heavy harrows with sharp tines, used immediately after mowing, will pull up all the grass which may spring up. No farmer ought to neglect having a few acres in lucern on his best land.

LUCERNAL MICROSCOPE. [Microscope.]

LU'CIDA, a name formerly given to the brightest star in any constellation: thus we have Lucida Hydræ, Lucida Lyræ, &c.

LUMBAGO. [Rheumatism.]

LUNACY. Unsoundness of mind is perhaps the most accurate definition of the present legal meaning of this term that can be given. Formerly a distinction was made between lunatics and idiots: a lunatic being described as one who has had understanding, but from some cause has lost the use of his reason; an idiot, as one who has had no understanding from his nativity. The distinction between these two classes of persons of unsound mind also produced some important differences in the management of their property. These have now fallen into disuse, and therefore it will be sufficient for the purposes of this article to consider the consequences to the individual of unsoundness of mind generally. Strictly speaking, perhaps a lunatic is one who has lucid intervals, but this distinction may also at the present day be disregarded.

Persons of unsound mind may inherit or succeed to land or personal property either by representation, devise, or bequest, but they cannot be executors or administrators, or make a will, or bind themselves by contract. It is stated by Blackstone that the conveyances and purchases of persons of unsound mind are voidable, but not actually void; this however perhaps needs some qualification, for a bargain and sale, or surrender, &c., and also personal contracts made or entered into by such persons, are actually void as against their heirs or other representatives, though it is true a feoffment with livery of seisin was voidable only. [Conveyances.] A person of unsound mind, though he afterwards be restored to reason, is not permitted to allege his own insanity in order to avoid his own act; for no man is allowed to stultify himself, or plead his own disability (13 Vesey, 590), unless he has been imposed upon in consequence of his mental incapacity (2 Carr. & P. 178; 3 Carr. & P. 1, 30); and an action will lie against a lunatic upon his contract for necessaries suitable to his station. The reader is referred for information upon this subject to 1 Blackst. *Comm.*, p, 297, Mr. Kerr's ed.; 1 Fonbl. *Eq.*, b. 1, c. 2; Sugd. *Pow.*, 295-6; 5 Barn. & C. 170; Moody & M. 105-6. Acts done during a lucid interval are valid, but the burden of proving that at the time when the act was done the party was sane and conscious of his proceedings, lies upon the person asserting this fact. The marriage of a person of unsound mind, except it be solemnised during a lucid interval, is void.

The degree of responsibility under which persons of unsound mind are placed with respect to crimes committed by them, as well as the degree of unsoundness of mind which should be considered as depriving the party of that amount of self-control which constitutes him a responsible agent, are in a painful state of uncertainty. As a general rule it may however be laid down that where unsoundness of mind, of such a nature as to render the party incompetent to exercise any self-control, is established, criminal punishment will not be inflicted; but that he will be kept in safe custody during the pleasure of the crown (39 & 40 Geo. III., c. 94, and 1 & 2 Vict., c. 14). On the subject of criminal responsibility, and what constitutes unsoundness of mind in a legal point of view, the reader is referred to the various treatises on medical jurisprudence. The following remarks may however be useful.

In lunacy the question to be decided is not whether the individual be actually of sound mind, though a jury on an inquisition held under a commission of lunacy must express their opinion or finding in the form that the alleged lunatic is of "unsound mind" (*In re Holmes*, 1 Russell, 182); but though such must be the finding in order to make a man legally a lunatic, the real question is whether or not the departure from the state of sanity be of such a nature as to justify the confinement of the individual, or the imposition of restraint upon him as regards the disposal of his property. No general rule can be laid down by which to ensure a right decision: but in all such inquiries it should be kept in mind that insanity varies infinitely in its forms and degrees. It should be particularly remembered that persons may be of weak mind, and eccentric, and even be the subjects of delusions on certain subjects, and yet both inoffensive and capable of directing pecuniary matters. The individual's natural character should be taken into consideration as accounting for eccentricities of manner and temper, and his education in estimating his ignorance and apparent want of intellect; and lastly due allowance must be made for the irritation and excitement produced in a mind, perhaps naturally weak, by the inquiry itself, and the attempt to deprive him of his liberty and property. Confidence should not be placed in depositions or evidence founded on short and inattentive examinations.

Sometimes the madman conceals his disease, and with such remarkable cunning and dissimulation that the detection of it is very difficult: this is more particularly the case when the insanity consists in some hallucination; and here, unless the nature of the delusion be known, it will often be in vain to attempt to elucidate by questions any proof of unsoundness of mind. Those who are insane on particular subjects will reason correctly on ordinary and trivial points, provided these do not become associated with the prevailing notions which constitute their disease.

When insanity is urged as the ground of non-responsibility for a criminal act, it has been erroneously held that the main point to be ascertained is, whether the individual has or had "a sense of good and evil," "of right and wrong." But this, though the doctrine of the English law, is found incapable of practical application; and the records of trials of this kind show that the guide to the decision has generally been the proof, or absence of proof, that insanity of some kind existed at the time of the act, although before and after it the power of reasoning and the knowledge of right and wrong might be retained. Thus, on the trial of Hatfield for shooting at George III., Erskine argued that the existence of a delusion in the mind absolves from criminal responsibility, if it be shown that the delusion and criminal act were connected; and on this principle Hatfield was acquitted, but confined for life. Bellingham, however, who shot Mr. Perceval under an equally powerful delusion, in consequence of the greater excitement in the public mind occasioned by the result of the insane act, was convicted and executed. In many instances homicide has been prompted, not by any insane hallucination or delusion, but by a morbid impulse to kill. Here there is generally evidence of the feelings and propensities of the individual having been previously disordered; of his being, in fact, the subject of moral insanity [Insanity], and judgment in such cases is aided by the absence of motive to the act.

A lunatic is, according to law, responsible for acts committed during "lucid intervals," a term by which is understood, however, not mere remissions of the violence of the disease, but periods during which the mind resumes its perfectly sane conditions. In forming an opinion concerning such lucid intervals, it is to be remembered that the absence of the signs of insanity must have considerable duration before it can be thence concluded that the mind is perfectly sane; and that lunatics, when apparently convalescent, are subject to sudden and violent paroxysms.

One of the most difficult points to be determined is with regard to the mental capacity of old persons, in whom the mind is confessedly impaired. The decay of intellect in old age is first manifested in the loss of memory of persons, things, and dates, and particularly with respect to recent impressions. But it is not the mere liability to forget names, &c., which will render the will of an old person invalid; it should be shown that in conversation about his affairs, and his friends and relations, he did not evince sufficient knowledge of both to dispose of the former with sound and untrammelled judgment. Many old men appear stupid and forgetful, but when their attention is fairly fixed on their property, business, and family affairs, they understand them perfectly, and display sagacity in their remarks.

The care and custody of idiots and lunatics form a branch of the royal prerogative, and were formerly administered by the king himself. Since the dissolution of the Court of Wards, the lord chancellor has been specially appointed to exercise this power. [Chancellor.] The method of proving a person to be of unsound mind, for the purpose of depriving him of the control of his property, and, where the circumstances require it, providing for the safe custody of his person, was formerly as follows. The lord chancellor, upon petition supported by affidavits, and in some cases upon a personal interview also with the alleged lunatic, when such a course seemed necessary, granted a commission to inquire into the state of mind of the party, and if the jury found him to be *lunatic*, or of *unsound mind* (one of which modes of finding was absolutely necessary), the care of his person was committed to some relation or other fit person with a suitable allowance for maintenance, who was called the committee of the person; and the care of the estate was committed either to the same or some other person, who was called the committee of the estate. [Guardian.] The committee of the estate was considered as a mere bailiff appointed by the crown for the sole interest of the owner, and without any regard to his successors; but the court might order allowances to be made to near relations of the party of unsound mind, and even to his natural child, where the circumstances of the several parties justified and required it, and would direct proper acts to be done in the management of the estate, as repair of buildings, felling of timber which was deteriorating, &c.

The procedure at present is essentially the same as formerly, but much legislation has recently taken place on the subject, and now the Act 16 & 17 Vict. c. 70, styled the Lunacy Regulation Act, 1853, has consolidated most of the laws and provisions previously in force. Under this Act the lord chancellor may appoint two serjeants or barristers-at-law, to be called masters in lunacy, who are to have and execute all the powers, duties, and authorities formerly had and executed by commissioners named in commissions in the nature of writs De Lunatico Inquirendo. The masters conduct their proceedings either separately or together under the orders and direction of the chancellor.

The chancellor also appoints three visitors, two medical and one legal, whose function it is to visit and report upon the condition of every lunatic of whom the court has the care.

The lords justices of the Court of Appeal in Chancery may also, by virtue of the Queen's sign manual, be entrusted with the care of lunatics, and have the same jurisdiction as the lord chancellor.

The term lunatic is only properly applied to a person who is found to be a lunatic by the verdict of a jury under an inquisition. But the term lunatic is also applied to those who, being considered lunatics, are confined in lunatic asylums or hospitals without having been found lunatics by inquisition.

The subject of insanity and asylums for the insane has of late years occupied a very large share of public attention; particularly as an opinion has prevailed that insanity is on the increase in this kingdom beyond the ratio of population. The want of accurate information renders this point doubtful; but it is certain that more than 20,000 insane persons are in confinement in the public asylums and licensed houses in England and Wales, of whom 16,000 are paupers. But as a great number of patients are confined separately, or in the care of their relatives, of whom no public returns are made, this number is probably far below that of the persons insane in the country.

Recent legislation has placed the powers vested in the commissioners in lunacy on an entirely new footing, and has in many respects modified the constitution of asylums. The Act 8 & 9 Vict. c. 100, repeals 2 & 3 Wm. IV. c. 107; 3 & 4 Wm. IV. c. 64; 5 & 6 Wm. IV.

c. 22; 1 & 2 Vict. c. 73; 5 Vict. c. 4; and 5 & 6 Vict. c. 87. The same Act appoints six commissioners, three of whom are physicians and three barristers, with salaries; and five other commissioners who act gratuitously. No person can act as a commissioner who within one year has been directly or indirectly connected with any asylum. Licences are granted by these commissioners at each of their quarterly meetings. Any person who wishes to open a house for the reception of patients is required to send a plan upon a scale of one-eighth of an inch to a foot of every part of the premises at least fourteen days previous to his application. No additions to or alterations in a licensed house can be made without the consent of the commissioners. No licence is to remain in force more than thirteen months, and the notice of a wish to renew must give the number of patients then confined. The jurisdiction of the commissioners extends to the whole of London and Middlesex, and Southwark; and to all places within seven miles of London, Westminster, and Southwark: in the country the licences are to be granted by the justices of the peace in quarter-sessions, who are bound to appoint three of their number, together with one physician, surgeon, or apothecary, as visitors of the asylums licensed by them. Strict regulations are enforced for the reception of patients; it is required that every person, not being a pauper, received as insane, shall be certified to be so by two physicians or surgeons, who shall visit such patient separately, and shall have no interest in the asylum in which such patient is to be confined; and certain entries of these particulars are to be kept at each asylum. For a pauper, the certificate of one medical man and the order of two justices is required.

Penalties are fixed for neglecting these rules, or those which direct notice to be given of every admission, death, discharge, or escape. Houses having 100 or more patients are to have a resident medical attendant, and those of smaller size are to be visited by a medical attendant at defined periods, according to their size. Every house within the immediate jurisdiction of the commissioners must be visited by them at least four times in the year, and every other house at least twice in the year; these visits may be made at any hour, even by night, and it is penal to conceal any part of a house from them. Similar powers are given to the visitors in the country.

The commissioners present an annual report to the lord chancellor of the state of the different asylums visited by them, which report is laid before parliament.

An important alteration is made in the law concerning the care of single patients. Orders and medical certificates must now be procured for the care of one patient, similar to those used for the admission of patients into licensed houses; and copies of these documents are to be privately sent to and registered by the secretary to the commissioners. This Act only extends to England and Wales, and is amended by 16 & 17 Vict. c. 96, and 18 & 19 Vict. c. 105.

The Act 16 & 17 Vict. c. 97, relates to the regulation of lunatic asylums for counties and boroughs, and the maintenance and care of pauper lunatics; and gives to the commissioners a great power over these institutions, which had formerly been entirely under the control of justices of the peace. The justices of every county and borough are now compelled to erect or to join in the erection of an asylum, where none such already exists. This Act only extends to England and Wales.

The patients who are confined in prisons, hospitals, workhouses, or in the houses of their relatives, are exposed perhaps more than any others to great neglect and mismanagement, and not unfrequently are treated with great cruelty, even when the intentions of the parties who have charge of them are good, through their entire ignorance of the nature and proper treatment of the disorder.

As to the persons and property of such so-called lunatics who have not been found lunatic by a jury, the 8 & 9 Vict. c. 100, § 94, enacts, That whenever the commissioners in lunacy shall have reason to suppose that the property of any person detained or taken charge of as a lunatic is not duly protected, or that the income thereof is not duly applied for his maintenance, such commissioners shall make such inquiries relative thereto as they shall think proper, and report them to the lord chancellor. Sect. 98 enacts, That when any person shall have been received or taken charge of as a lunatic upon an order and certificate under the provisions of that Act, and shall either have been detained as a lunatic for the twelve months then last past, or shall have been the subject of a report by the commissioners in lunacy in pursuance of § 94, the lord chancellor shall direct one of the masters in lunacy to inquire and report to him as to the lunacy of such person so confined; and the chancellor is authorised to make orders for the appointment of a guardian or otherwise for the protection, care, and management of such lunatic, and such guardian is to share the same powers and authorities as a committee of the person of a lunatic found such by inquisition has, and to appoint a receiver or otherwise for the care and management of the estate of such lunatic; and such receiver is to have the same powers as a receiver of the estate of a lunatic found such by inquisition has; and the chancellor is also empowered to make orders for the application of the income of the lunatic towards his maintenance, and the cost of the care and management of his person and estate, and also as to the investment or other application for the purpose of accumulation of the overplus; but such protection, care, and management are only to continue so long as such lunatic shall continue to be detained as a lunatic upon such order or certificate as aforesaid, and such further time, not exceeding six months, as the chancellor may fix; but the chancellor may in any such case, either before or after directing such inquiry, and whether the master shall have made such inquiry or not, direct a commission in the nature of a writ *de lunatico inquirendo* to issue, to inquire of the lunacy of such person.

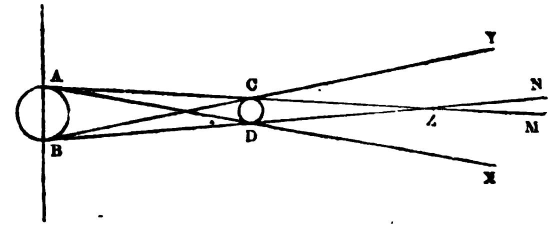
In the Roman system, persons of unsound mind (*furiosi*) might be deprived of the management of their property on application to the prætor by their next of kin. This legislation was either introduced or established by the Twelve Tables. The person who had the care of the lunatic and of his property was called a curator. [Curator.] The Twelve Tables gave the care of the lunatic to his agnati. In those cases where the law had not provided for the appointment of a curator, the prætor named one. ('Dig.' 27, tit. 10; 'Instit.' 1, tit. 23.)

The law with respect to lunatics in Scotland is consolidated by the statute 20 & 21 Vict. c. 71, as amended by the 21 & 22 Vict. c. 89.

The Act 5 & 6 Vict. c. 123, continued by 18 & 19 Vict. c. 76, provides for private lunatic asylums in Ireland. The Acts 1 & 2 Geo. IV. c. 33; 9 & 10 Vict. c. 115; and 18 & 19 Vict. c. 109, regulate the asylums for the lunatic poor in Ireland.

LUNAR CAUSTIC. [Silver, Nitrate of.]

LUNAR ECLIPSE. The phenomenon of a lunar eclipse is occasioned by the passage of the moon through the earth's shadow, and the consequent interception of a portion of the solar light which usually falls upon the moon's surface. In the annexed figure, let A B



represent a section of the sun drawn through a great circle on its surface, and C D a similar section of the earth's surface, both sections being supposed to be in the same plane. Let the common tangents to these sections, A X, B Y, A M, B N, be drawn. In consequence of the great distance of the sun these tangents may be supposed to intersect each other at A, B and C, D, the opposite extremities of two parallel diameters. It is plain that the space C D Z is a section of a cone, and that within its limits there will be a total interception of the sun's light. Hence, when the moon in the course of her monthly revolution passes into this cone, she will undergo an eclipse, which will be total or partial, according as she plunges wholly or partially into the terrestrial shadow. Within the region enclosing the shadow represented by Y C Z, Z D X, there will be a partial interception of the solar light. This region is termed the penumbra. If the moon revolved in the plane of the ecliptic, she would pass through the terrestrial shadow every time that the earth was interposed between her and the sun, and consequently she would undergo an eclipse in the course of each monthly revolution; but, in point of fact, the lunar orbit is inclined to the plane of the ecliptic at a mean angle of somewhat more than 5°. It happens, from this circumstance, that an eclipse of the moon can occur only when the moon is near either of the nodes of her orbit. It is found, by calculation, that if the distance of the node from the point of the ecliptic opposite to the sun should exceed 11° 25′ 40″, there will be no eclipse. On the other hand, if the distance of the node from the same point should fall short of 9° 20′ 29″, there *must* be an eclipse. Within these limits there may or may not be an eclipse, the question of the occurrence of such a phenomenon depending on the relative distances of the sun and moon from the earth at the time of opposition.

It has been found by observation that even when the moon is totally immersed in the earth's shadow she still continues to be visible, her surface being distinguishable by a dull copper colour. This is occasioned by the light passing through the terrestrial atmosphere being refracted so as to fall on the moon's surface. The ruddy colour of the moon is due to the absorption of the violet rays by the terrestrial atmosphere. The colour of the moon's surface during an eclipse is subject to considerable variations. Sometimes the degree of obscuration is very slight; on other occasions it is so great that the moon ceases to be visible. Generally, it may be stated that the colour of the moon's surface will depend on the condition of the earth's atmosphere at the time of the eclipse.

LUNAR EVECTION. An inequality in the moon's longitude, occasioned by the disturbing force of the sun. It depends on the variable excentricity of the lunar orbit and the moveable position of the apsides. The discovery of this inequality is due to Ptolemy. For an explanation of its physical cause, see Gravitation.

LUNAR OBSERVATION generally means an observation of the moon's distance from a star, for the purpose of finding the longitude. [Longitude and Latitude, Methods of Finding.]

LUNAR THEORY. By the theory of a planet is meant the deduction of its motion from the law of gravitation. This subject is discussed in the article GRAVITATION. For the numerical data see MOON.

LUNATIC ASYLUMS. In every civilised country the necessity of at least guarding against any calamitous result from the loss of reason in any of the members of society, must have been a serious consideration. In the East, idiots or harmless lunatics are considered as holy, and are usually provided for by the benevolent, but no public care seems to be bestowed even on the more violent. The buildings in cemeteries are often the abodes of such sufferers. Mr. Warburton ('Crescent and Cross,' ii. 352) states, that when travelling in Lebanon, and near a Moslem village, "the silence of the night was now broken by fierce yells and howlings, which I discovered proceeded from a naked maniac, who was fighting with some wild dogs for a bone." This madman, on being disturbed, made an attack on Mr. Warburton. Unfortunately, it appears to have been taken for granted that such maladies were incurable, and coercion and confinement were the chief appliances used in all cases where any restraint appeared necessary. Even Shakspere makes Rosalind say, "a dark house and a whip" are what madmen deserve; and Malvolio is to be had "in a dark house and bound." When they were supposed to be harmless, lunatics and idiots were suffered to wander about the country, trusting to precarious charity, and subjected to occasional whippings. These provisions, such as they were, became manifestly insufficient, and asylums were sparingly provided, where probably the worst cases were received. But though shelter was thus given, the treatment did not greatly vary. It was still the dark house and the whip. The system pursued was always one of coercion and severity, too frequently of cruelty. In the old hospital of Bethlem in Moorfields, London, the poor lunatics were made a show of, as if they had been wild beasts, and the miserable patients were excited to rage to render the exhibition more stimulating. Henry Mackenzie, in his 'Man of Feeling,' published in 1771, describes with other sensations a visit to this place. "Their conductor led them first to the dismal mansions of those who are in the most horrible state of incurable madness. The clanking of chains, the wildness of their cries and the imprecations which some of them uttered, formed a scene inexpressibly shocking. Harley and his companions, especially the female part of them, begged their guide to return: he seemed surprised at their uneasiness, and was with difficulty prevailed on to leave that part of the house without showing them some others; who, as he expressed it, in the phrase of those that keep wild beasts for show, were much better worth seeing than any they had passed, being ten times more fierce and unmanageable." Mackenzie makes Harley observe, "I think it an inhuman practice to expose the greatest misery with which our nature is afflicted, to every idle visitant who can afford a trifling perquisite to the keeper; especially as it is a distress which the humane must see with the painful reflection that it is not in their power to alleviate it." The last plate of Hogarth's 'Rake's Progress,' of a date a few years earlier, gives even a more vivid picture of a madhouse of the period. Nearly naked, in chains, his head shaved, in a dirty straw-littered cell, and wildly raging; "a monumental figure over the grave of his reason," as Lichtenberg, the German commentator on Hogarth, expresses it, the poor maniac is yet exhibited by his stern-looking keeper. Still the system was continued; thousands went to see, hundreds perhaps to pity, but none to remedy. The only approximation was, that this shameful exhibition was prohibited in 1771.

Such scenes were not peculiar to England. They could have been paralleled, perhaps exceeded, in every state throughout Europe. But relief was approaching, and it began in France.

The benevolent and courageous Pinel was the first to attempt the restoration of the insane to a position among human beings. The scene of his exertions, which were the first great step of the non-restraint system, was the Bicêtre—a hospital for insane men, near Paris. In this frightful prison the universal practice was to load patients with heavy chains, which remained on for the remainder of their lives, and to immure them in dark, unwarmed, and unventilated cells. Pinel determined on at once releasing a large number of patients. The following account of the experiment is extracted from the 'British and Foreign Medical Review:'—

"Towards the end of 1792, Pinel, after having many times urged the government to allow him to unchain the maniacs of the Bicêtre, but in vain, went himself to the authorities, and with much earnestness and warmth advocated the removal of this monstrous abuse. Couthon, a member of the commune, gave way to M. Pinel's arguments, and agreed to meet him at the Bicêtre. Couthon then interrogated those who were chained, but the abuse he received, and the confused sounds of cries, vociferations, and clanking of chains in the filthy and damp cells, made him recoil from Pinel's proposition. 'You may do what you will with them,' said he, 'but I fear you will become their victim.' Pinel instantly commenced his undertaking. There were about fifty whom he considered might without danger to the others be unchained, and he began by releasing twelve, with the sole precaution of having prepared the same number of strong waistcoats with long sleeves, which could be tied behind the back if necessary. The first man on whom the experiment was to be tried was an English captain, whose history no one knew, as he had been in chains forty years. He was thought to be one of the most furious among them; his keepers approached him with caution, as he had in a fit of fury killed one of them on the spot with a blow from his manacles. He was chained more rigorously than any of the others. Pinel entered his cell unattended, and calmly said to him, 'Captain, I will order your chains to be taken off, and give you liberty to walk in the court, if you will promise me to behave well and injure no one.' 'Yes, I promise you,' said the maniac; 'but you are laughing at me: you are all too much afraid of me.' 'I have six men,' answered Pinel, 'ready to enforce my commands, if necessary. Believe me then, on my word, I will give you your liberty if you will put on this waistcoat.' He submitted to this willingly, without a word: his chains were removed, and the keepers retired, leaving the door of the cell open. He raised himself many times from the seat, but fell again on it, for he had been in a sitting posture so long that he had lost the use of his legs; in a quarter of an hour he succeeded in maintaining his balance, and with tottering steps came to the door of his dark cell. His first look was at the sky, and he cried out enthusiastically, 'How beautiful!' During the rest of the day he was constantly in motion, walking up and down the staircases, and uttering exclamations of delight. In the evening he returned of his own accord into his cell, where a better bed than he had been accustomed to had been prepared for him, and he slept tranquilly. During the two succeeding years which he spent in the Bicêtre, he had no return of his previous paroxysms, but even rendered himself useful by exercising a kind of authority over the insane patients, whom he ruled in his own fashion." Other instances are given of the efficacy of the mild treatment, which are not necessary now to be repeated to show its salutary effects.

If experience did not always prove that improvements of any kind are slow, and invariably met by opposition, we should be at a loss to account for the fact that in England, twenty-three years after the liberation of the lunatics at Bicêtre, a state of things equally bad, if not worse, generally existed. From the evidence given before the parliamentary committees in 1815, we gather facts, supported by the evidence of the attendants themselves, almost too horrible to be credible. Every artifice of cruelty seems to have been employed upon those who were already the most unhappy of mankind. The idea seemed to prevail that all the feelings of humanity were extinguished by the visitation of insanity. The keepers were, in all the English madhouses, of the lowest and most brutal character, merely distinguished by their success in controlling the violence of their patients by still greater violence, and by possessing the power of punishment. The account of the inquiry into the management of the York Asylum in 1813, written by the late respected Mr. Gray, gives probably a true picture of the state of the condition of the insane in general. This asylum was opened in 1777, and bore a fair character for organisation and management. Upon the establishment of the Retreat, at York, in 1796, a more humane system than had hitherto been known in England was introduced into its management; and in the description of it by the founder, Mr. Tuke, published in 1813, a recommendation of the milder mode of treatment was given. This was considered, and with some reason, to be an attack upon the management of the York Asylum; and it was followed up by a series of charges brought by Mr. Godfrey Higgins against this latter institution. The horrors ultimately made known would be beyond belief, were they not amply attested. Though the committee of the York Asylum long refused to listen to the charges brought by Mr. Higgins, they could not entirely conceal the facts; and the extent to which frauds of all kinds were carried by the steward assisted much in developing the general state of the house. A committee of inquiry was appointed; and on the day after their deliberations ceased (28th December, 1813), one wing of the asylum was destroyed by fire. How many patients perished is unknown; but at least four were missing. The steward entered four patients who were missing as "died;" but it is probable that there were many more. The real number in the house was probably unknown; for either by negligence or design the books had been so irregularly kept that the number of deaths to July, 1813, actually 365, was entered as 221, and 101 of those dead had been calculated among the cures. The committee refused to adopt the only method of ascertaining the number missing by requiring from each keeper an account of the patients under his care, from a pretended delicate objection to the divulging of the names of the inmates.

Mr. Higgins thus sums up the state of the management of the house:—"In the asylum investigations, concealment appears at every step of our progress; 365 have died: the number advertised is 221. A patient disappears, and is never more heard of, and is said to be 'removed.' A patient is *killed*—his body is hurried away to prevent an inquest. He is *cured*, but it is by some medicine the composition of which is known only to the doctor. The public cry out that a patient has been neglected; there is a levy *en masse* of respectable governors to quell the disturbance, and to certify that the patient has been treated with *all possible care, attention, and humanity*. A committee of investigation desires to be shown the house: certain cells 'in an extreme state of filth and neglect' are omitted to be pointed out to them. The governors examine the accounts: there are considerable sums of which neither the receipt nor the application appears. They inspect the physician's report: it only aids the concealment. The steward's books are inquired for: in a moment of irritation he selects for the flames such of them as he thought it not advisable to produce. And yet every circumstance of concealment is imputed by some to mere accident; and every attempt to tear off the mask, and exhibit the asylum in its true character, is stigmatised as a libel or an indelicate disclosure!"

The details which were brought before the committee to exhibit the brutality and profligacy of the keepers need not be repeated; but it is gratifying to find that Mr. Higgins persevered, notwithstanding all the obloquy heaped upon him, until a complete change of the officers and of the system was brought about.

The next asylum of which we shall have occasion to notice the mismanagement is Bethlem, concerning which we find many particulars in the evidence given before the parliamentary committee in 1815.

The severest restraint and the most cruel neglect seem to have been the almost uniform practice; and it must not be forgotten that this royal hospital, favoured with exemption from all visitation and from the effects of acts of parliament, has been, until a recent period, the most determined in resisting the abolition of restraint, in preserving ancient abuses, and in closing its doors against inspection. With such large funds at command, Bethlem ought to be a model where the student of medicine may see every late improvement in the treatment of mental disorder carried into effect, without regard to the economy which has been detrimental to the improvement of many other asylums. And Bethlem now (1860) does indeed boast of being the most advanced in the system of non-restraint: public balls and other amusements being allowed to the patients.

In 1815 Bethlem appeared to have been going back, rather than improving, for half a century. From the time that the indiscriminate visits of the public had been prohibited, the secrets of the institution were known only to a few. The case of Norris, a patient in Bethlem, which was made public by the parliamentary committee, has often been related; but it will not be out of place here. William Norris had been an officer in the navy, and was first confined at Bethlem in 1801. In 1803 he is said to have struck Mr. Haslam, the apothecary; and whether from any real fear of him or as a punishment, a new and most ingenious instrument of torture was invented for his confinement. "A stout iron ring was riveted round his neck, from which a short chain passed to a ring made to slide upwards or downwards on an upright massive iron bar, more than six feet high, inserted into the wall. Round his body a strong iron bar, about two inches wide, was riveted; on each side of the bar was a circular projection, which being fashioned to and inclosing each of his arms, pinioned them close to his sides. The waist bar was secured by two similar bars, which, passing over his shoulders, were riveted to the waist bar both before and behind. The iron ring round his neck was connected to his shoulders by a double link. From each of these bars another chain passed to the ring on the upright iron bar. His right leg was chained to the trough, in which he had remained thus encaged and enchained twelve years. He read books of all kinds, and reasoned quite coherently on the events of the war." During the whole of this period it was impossible for him, from the nature of the restraint in which he was placed, either to stand quite upright or to lie down at ease. It will be no matter of surprise that he died on the 26th of February, 1815.

From this time a gradual but very slow improvement in the condition of the insane may be observed. Chains were removed, and leathern restraints of much milder kinds substituted; and more care was given to the warming and clothing of the patients. Some of the largest asylums in England were opened between 1815 and 1825. The introduction of employment by Sir William Ellis at Wakefield, and afterwards at Hanwell, was a great advance in the amount of confidence reposed in patients; employment has since been introduced in almost every asylum, and no serious accident, so far as we are aware, has ever occurred from allowing the use of tools. The credit of declaring the total abolition of mechanical instruments of restraint to be desirable and practicable, belongs to Dr. Charlesworth and Mr. Hill, of the Lincoln lunatic asylum. The progress of the alteration was given by Mr. Hill in a lecture delivered by him at the Lincoln Mechanics' Institution, 21st June, 1838, and afterwards published with the addition of extracts from the 'Proceedings' of the asylum, and tables showing the gradual disuse of restraint. A reference to a few of these will illustrate this part of the history of the non-restraint system. The Lincoln asylum was opened on the 26th April, 1820, and was conducted from the first on humane principles, but with all the usual instruments of restraint.

On the 29th February, 1829, it is reported that a patient has died in the night in consequence of being strapped to the bed in a strait-waistcoat, and an order is consequently given that the use of the strait-waistcoat shall be discontinued, except under the special written order of the physician; and also that every case of restraint shall be entered in a journal, with its nature and duration.

On the 4th May, in the same year, the "heaviest pair of iron hobbles," which were jointed, and weighed 3 lbs. 8 oz., and the "heaviest pair of iron handcuffs," which weighed 1 lb. 5 oz., are ordered to be destroyed; five strait-waistcoats are likewise condemned.

Numerous entries in 1829, 1830, 1831, and 1832 prove the diminished use of coercion. On the 16th July, 1832, is the first order for strong dresses for such patients as tear their clothes. These patients were in all asylums the most subject to continual restraint.

21st July, 1834. All the instruments which would confine the fingers were ordered to be destroyed; but manacles for the wrists and leg-locks were retained. March, 1837, the system of restraint was entirely abolished.

Mr. Hill's lecture, which contains much that is exceedingly interesting upon this subject, has the following sentence, which has been the text on which all the controversy on the abolition of restraint has been founded:—"In a properly constructed building, with a sufficient number of suitable attendants, restraint is never necessary, never justifiable, and always injurious, in all cases of lunacy whatever." This sentence, when published in 1838, was declared even by those most inclined to the new system to be too decided, and likely to produce a bad effect; but fortunately the lapse of twenty years has proved its perfect truth, by its adoption as a principle in all the most important asylums in the kingdom. But the upholders of the old system received the announcement of a doctrine so startling as if there were something atrocious in proposing to liberate those who were unfortunate enough to be insane; and for years after restraint had been actually abolished, the non-restraint system was declared "utopian" and impracticable; then declared to be practicable, but not desirable; and at length, when every other argument failed, those who so strenuously opposed it came forward and claimed it as their own system, which they had been practising for years, excepting that it had been carried a little further.

The next asylum in which restraint was abolished was that of the county of Middlesex at Hanwell. At the time of the appointment of Dr. Conolly to the superintendence of the Hanwell Asylum (June, 1839) it contained eight hundred patients; of these about forty were almost constantly in restraint-chairs, and a number of others wore strait-waistcoats, muffs, leg-locks, &c. In addition to these restraints, which were supposed necessary for the safety of the rest and of the officers and attendants, more than a hundred epileptic patients were fastened by one wrist in bed every night. This was considered a necessary precaution to prevent the patients from falling out of bed or from turning on their faces in a fit, and so becoming smothered, which, it is asserted, has sometimes happened. No such cases however have occurred since the disuse of the hand-strap, which took place in July, 1839.

We extract from Dr. Conolly's first report (October, 1839) the following account of the discontinuance of restraint at Hanwell:—

"The article of treatment in which the resident physician has thought it expedient to depart the most widely from the previous practice of the asylum has been that which relates to the personal *coercion* or forcible *restraint* of the refractory patients. Without any intention of derogating from the high character acquired by the asylum, it appeared to him that the advantage resulting from the degree of restraint permitted and customary in it at the period of his appointment was in no respect proportionable to the frequency of its application; that the objections to the restraint actually employed were very serious; and that it was in fact creative of many outrages and disorders, to repress which its appplication was commonly deemed indispensable, and consequently directly opposed to the chief design of all treatment, the cure of the disease."

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"By a list of restraints appended to this report, it will be seen that the daily number in restraint was in July so reduced that there were sometimes only four, and never more than fourteen, in restraint at one time; but that since the middle of August there has not been one patient in restraint on the female side of the house, and since the 21st of September not one on either side." The 51st report of the visiting justices, which accompanies this report, speaks of the new system as requiring an additional number of attendants, and of a superior class to those previously employed.

In their 52nd report (January, 1840) the visiting justices report the satisfactory results of the new system. In the 53rd (April, 1840) they report that "there has not been a single occurrence to weaken their confidence in the practicable nature of the system;" and also "that no increased destruction of clothing or other property is occasioned by the personal freedom which the patients enjoy. Indeed, so far as clothing is concerned, the amount of destruction is somewhat lessened, because of the general tranquillity of the patients from the adoption of the new system."

Dr. Conolly, in 1844, also says: "After five years' experience, I have no hesitation in recording my opinion, that with a well-constituted governing body, animated by philanthropy, directed by intelligence, and acting by means of proper officers, intrusted with a due degree of authority over attendants properly selected and capable of exercising an efficient superintendence over the patients, there is no asylum in the world in which all mechanical restraints may not be abolished, not only with safety, but with incalculable advantage."

Here we may consider the subject of non-restraint concluded so far as its practicability is concerned. It is nowhere insisted that restraint can never be necessary in ill-conducted asylums, and until houses for private patients are constructed for the purpose for which they are used, some restraint will probably be used in many of them.

In the article LUNACY we have given notices of the various legislative acts for the management of Lunatic Asylums, and the appointment of commissioners, who are bound to examine frequently, and to report annually on the state of every public or registered asylum for the care of the insane. From their last report, the thirteenth, for the year ending December 31, 1858, it appears that there are 44 county and borough asylums now in England (2 of them, Cumberland and Glamorgan, not yet (1860) open). The only large town not possessing one is the city of London, notwithstanding the repeated remonstrances of the commissioners; but one is about to be erected at last at Dartford. There are 38 metropolitan and 74 provincial licensed houses; with 15 hospitals which receive lunatics, including the one at Earlswood for idiots only. The following is the summary as given in the Commissioners' Report for the year ending December 31, 1858:—

COUNTY.	Number of Patients.	In County or Borough Asylums.	In Registered Hospitals or Licensed Houses.	In Workhouses.	In Lodgings, or Boarded out.	Residing with Relatives.
ENGLAND:						
Bedford	245	140	9	52	2	42
Berks	491	297	10	75	12	97
Bucks	259	175	1	35	1	47
Cambridge	256	122	5	42	2	85
Chester	527	245	1	178	22	81
Cornwall	428	248	..	80	22	78
Cumberland	301	1	116	135	10	39
Derby	391	210	..	108	19	54
Devon	968	568	1	179	66	84
Dorset	322	210	9	83	5	65
Durham	405	164	2	165	15	59
Essex	633	357	1	142	25	108
Gloucester	1032	464	29	333	41	165
Hereford	226	111	..	28	26	61
Hertford	371	170	13	92	19	77
Huntingdon	87	54	1	10	5	17
Kent	994	534	68	299	8	85
Lancaster	2862	1859	118	1086	44	255
Leicester	545	253	6	174	24	88
Lincoln	561	329	11	104	22	95
Middlesex	3686	2073	618	951	5	39
Monmouth	288	185	2	35	20	46
Norfolk	785	315	112	130	28	200
Northampton	447	28	200	89	26	104
Northumberland	422	22	146	127	15	112
Nottingham	546	264	2	201	9	70
Oxford	355	213	5	62	10	65
Rutland	30	22	..	5	1	2
Salop	453	240	..	106	20	87
Somerset	871	367	..	205	53	246
Southampton	882	469	3	273	26	111
Stafford	679	423	..	208	2	46
Suffolk	615	294	46	112	20	143
Surrey	1364	812	70	405	9	68
Sussex	566	38	248	151	27	102
Warwick	708	511	6	122	19	50
Westmoreland	99	..	15	65	6	13
Wilts	594	322	1	104	20	147
Worcester	598	355	..	125	24	94
York, East Riding	398	224	27	98	10	39
„ North „	302	198	..	52	15	37
„ West „	1512	808	20	434	42	208
Total	28,104	14,194	1922	7410	767	3811
WALES:						
Anglesey	87	13	..	..	35	39
Brecon	107	44	..	7	21	35
Cardigan	142	6	18	1	37	80
Carmarthen	166	..	37	13	28	88
Carnarvon	224	45	..	18	64	97
Denbigh	131	47	..	48	30	6
Flint	135	48	..	27	11	49
Glamorgan	326	38	104	49	28	107
Merioneth	82	17	..	12	19	34
Montgomery	171	62	..	45	35	29
Pembroke	148	26	16	12	29	65
Radnor	35	13	..	..	8	14
* Total	1754	359	175	232	345	648
Grand total	29,858	14,553	2097	7642	1112	4454

In the year there had been 8146 admissions; and 4942 discharges, of which 3079 were recoveries, of which 1399 were males and 1680 females. Of the patients remaining, 2779 were deemed curable. There had been 2306 deaths, of which 1274 were of males, and 1032 females: 7 females and 5 males had committed suicide.

The report of the commissioners on their visitations was on the whole favourable. The chief complaint was the want of space for exercising grounds; the neglect of providing night assistants, which the commissioners strongly urge, as the best means of counteracting the habits of dirty patients and for the prevention of accidents; and the insufficiency of the pay to secure able and trustworthy assistants. On the whole, they find that the system of personal restraint has been nearly altogether abandoned, and that of solitary confinement greatly, but not as they think sufficiently lessened. Their efforts, however, have not been altogether effectual. Some remnants of the old system remain, in spite of their remonstrances, in the private asylums. They thus describe one:—"The premises present a cheerless aspect. Many of the rooms have no windows, and are entirely dark. Some are lined with sheet-iron. The windows are guarded with heavy iron bars, and those, with the iron gates and railings, give the place a most jail-like appearance. Some of the sitting-rooms are without furniture, except fixed forms, and boards against the walls for tables. In these the floors are flagged, and the windows placed high up near the ceiling. There are out-buildings, where the patients are placed without attendants, and where no means for warming exist. The airing-court walls are high, and obstruct the view of the surrounding country." This is the state after some improvements had been made, and after repeated remonstrances.

Of the Asylum for Idiots at Earlswood, the reports published by the directors speak most favourably, though that of the Lunacy Commissioners is not altogether so commendatory. It recommends more attention to the improvement of the physical condition of the patients, with more of out-of-door exercise, thus developing their feeble intellect, with less pressure upon it by scholastic tuition; adding, in a report of February 23, 1859, that these recommendations have been adopted, and that its present management reflects credit upon the officials. At that date there were upon the premises 279 pupils, 187 of whom were males, and 92 females. The institution has been remarkably successful in developing the intellect, so as to make the patients at least useful and well ordered, in humble branches of industry, consequently more happy themselves, and a less burden to their friends and families.

In *Scotland*, the custody of the insane was, like every other matter which demands both magisterial and executive intervention, connected with the system of local courts. The law on the subject is now embodied in the 20 & 21 Vict. c. 71, as amended by the 21 & 22 Vict. c. 89, and the system of management of the insane in Scotland has, both in a purely medical and in an administrative point of view, been vastly improved. Until a comparatively late period the statute law was nearly inoperative, from a strong prejudice against the enforcement of general rules relating to the treatment of the insane, and the consequent toleration for breaches of the statutory regulations. The rule adopted in practice was, that insane persons were allowed to go at large until they had proved themselves dangerous to the lives of their neighbours, and that when confinement was in any case resorted to, the proceedings were not very rigidly investigated. There are now 8 public asylums, 24 private asylums, and 27 poorhouses, in which lunatics are maintained, and there are 1784 paupers kept in private houses. The total number of lunatics at the end of 1858, was 5748, of whom 2718 were males, and 3030 females; of this total 4787 were paupers. In the year, 188 males and 182 females had died. There had been 244 males and 379 females discharged recovered, and 198 males and 216 females not recovered. The admissions in the year were, 705 males and 921 females. In 1859, the number had been a little over 5000, of whom 392 died, and 497 were cured. The proportion of cures to deaths had been improving every year since 1856.

In *Ireland*, two inspectors of lunatic asylums, with the requisite assistants, have been appointed; and the erection of county lunatic asylums has been zealously carried forward. There are now 16 district asylums in operation, several of them being for the reception of patients from two or more counties which have associated themselves for that purpose; and a central one at Dundrum, county of Dublin. Between 1855 and 1860, there was expended on the construction of such asylums the sum of 356,114*l*. The ninth report of the inspectors of Irish lunatic asylums, gives the total number of the insane of all kinds on March 31, 1859, as 11,218, of this number (at the end of 1857), 4262 were at large, there not being sufficient accommodation for them in asylums at that time; the number being no doubt greatly reduced in the interval. Of the remainder, 2087 males and 2003 females were in the district asylums; 89 males and 41 females were in the central asylums; in jails, 116 males and 107 females; in poorhouses (April 2, 1859), 722 males and 1324 females; and in private asylums (December 31, 1858), 254 males and 213 females; giving a total of 3268 males and 3688 females under care and supervision. There are, in addition, 44 women and 30 men in the Dublin Hospital for Incurables. The general management, treatment of the patients, and construction of the buildings, are similar to those adopted in Great Britain, modified in some unimportant details by peculiar circumstances.

So many public asylums having been built, there has been a great variety of construction. The chief requisites insisted on by the commissioners, are light, ventilation, proper means of warming, convenience and cheerfulness in the furniture, and, above all, ample means for out-door exercise. The only doubtful part of the arrangement is the dormitories, some good authorities preferring open wards, as admitting the most effective superintendence at night; others advocating separate sleeping apartments, as being less likely to admit of any one patient disturbing another. Both plans have been adopted; and the results do not appear to differ materially.

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* Patients chargeable to counties and boroughs, and also certain criminal patients, are not included in the above totals.

A great improvement has taken place in the class of persons appointed as attendants, or, according to the old phraseology, *keepers*. That all such persons should possess benevolence and intelligence is essential to the effective working of a humane and enlightened system; and they should be liberally paid. The proportion of attendants to patients in the different English public asylums varies from one to ten, to one to twenty; the former does not seem too much, and is far less than that in all well-managed private asylums. No ward, however small, should have less than two attendants, in order that it should never be left without one; this is enforced by the rules of several asylums; and is most essential wherever a night attendance is adopted. In some asylums this attendance is endeavoured to be effected by making the day attendants undertake night duty in turns; but this is taxing their physical powers too severely, even when they are released from duty for half the succeeding day.

LUNATION, the time between two new moons. [Moon.]

LUNE, LUNULE, the figure formed on a sphere or on a plane by two arcs of circles which inclose a space. [Hypothenuse; Sphere.]

LUNETTE, in fortification, is a work similar to a ravelin, or demilune, but generally of smaller dimensions. Such works have been placed in the retired angles between the ditches of a bastion and of the collateral ravelin, but they are now usually considered as advanced works, and are placed in front of those just mentioned.

The form of a lunette is the same as that of the redoubt Y in the plan at the end of the article Fortification; and its positions may be understood by conceiving such works to be placed beyond the glacis S S on lines passing through P and Z, X and R, and produced. Each lunette is protected in front by a ditch beyond which is a covered-way, as usual.

The best disposition for a series of such works is that in which they are alternately more and less advanced beyond the fortress; since then they afford one another a reciprocal defence by the crossing fires which may be kept up from the nearest faces of every salient and retired lunette. And should the besiegers succeed in carrying their approaches up the glacis of the latter, the artillery on the flanks of the two more salient and collateral lunettes would effectually prevent them from forming a battery on its crest to breach the work. The operations against any one retired lunette must consequently be postponed till the two collateral lunettes are taken; whereas had all been equally advanced beyond the fortress, the three might have been breached and assaulted at the same time.

To give the more advanced lunettes, which are generally those placed beyond the ravelins, all the advantages of which they are susceptible, the magistral lines of their faces should coincide with the sides of an equilateral triangle whose base is a line joining the faces of the two collateral bastions at points about twenty or thirty yards from their flanked angles; for thus the earthen parapets at the salient angles of the lunette will not be easily destroyed by rain, and the ditches before the faces of the work can be defended by two or more pieces of artillery conveniently placed on the faces of the bastions. The ditches of the retired lunettes should in like manner be defended by artillery placed on the faces of the collateral ravelins; and the magistral lines of their faces should consequently be directed towards such ravelins.

In a front of fortification of the ordinary extent (360 yards) this rule for placing the advanced lunette, will permit the ditch and covered-way of the latter to be defended by a fire of musketry from the retired places of arms L L [Fortification], and from the covered-way before the bastions; and, that such fire may graze the bottom of the ditch of the lunette, this ditch ought to be in an inclined plane nearly coinciding with the slope of the glacis S S. Should the ditch so formed be too shallow to fulfil its end, which is that of being an obstacle to the enemy in his attempt to assault the lunette, it would be necessary to make it deeper; and that it might not thus become a trench in which the enemy would be covered from the fire of the defenders, it should communicate with water, by which it might be filled previously to the expected assault.

The rampart of a lunette differs in no respect from that of other works; it should have the same relief, or height above the natural ground, as is given to the ravelins; since, as in the latter work, the fire of artillery should be capable of being directed against the trenches of the enemy at the foot of the glacis, over the heads of the defenders on the banquette of the covered-way. Its escarp should be revêted with brick or stone, in order that the enemy may be compelled to form a breach in it by artillery, or by a mine, previously to making an assault; or at least that the attack by escalade might be a process of difficulty and danger. The terreplein, or ground in the interior, should be high enough at the gorge to prevent an enemy from entering there without scaling-ladders; this part should be further protected by a loop-holed wall, or a line of palisades; it should be seen and defended from some collateral work, and an open caponnière, or a subterranean gallery, for communication, should lead from the gorge of each lunette to the place of arms in its rear. The advanced covered-way should pass in front of all the lunettes, and it might terminate at the two extremities on inaccessible ground, or in the general covered-way of the place.

Advanced lunettes about a fortress form strong posts for artillery, by which an enemy is compelled to commence his approaches at a greater distance than would otherwise be necessary. The length of their faces may be from sixty to seventy yards, and that of their flanks from fifteen to twenty. It is considered that a well-disposed series of these works would prolong the defence of a place about ten or twelve days. But they are only proper for fortresses of the first magnitude, since they would require a large garrison; and the troops on being compelled to retire, might not find sufficient room in a small place.

LUNGS, DISEASES OF THE. The highly organised structure of the lungs and the incessant exercise of their important function, frequently under noxious circumstances, render these organs perhaps the most liable to disease of any in the body. Exposure to damp and cold, sudden atmospherical changes and transitions of temperature, want of proper nourishment, inattention to personal cleanliness, and some of the mechanical employments in which the confined and heated atmosphere of workshops is impregnated with minute particles of foreign substances, such as steel, wool, &c., may be considered as amongst the chief exciting causes of this extensively prevailing class of diseases. The subject may be conveniently divided into those affections which are acute and rapid in their progress, and those in which their course is slower and the changes of structure more gradually effected.

In *inflammation of the lungs* (pneumonia peripneumonia) the air-cells and parenchymatous structure of the organ are the seat of the disease. This affection is generally preceded in a greater or less degree by shivering and such other febrile symptoms as commonly usher in any febrile attack. Soon afterwards pain and a sense of oppression are felt in the chest, with hurried respiration and a short dry cough. The pain is sometimes severe, sometimes it is described as of a dull and obscure kind and deeply seated. If the pleura, or investing membrane of the lungs, participate in the affection, it is generally severe. At first there is little expectoration, but this increases in the progress of the disease, and the sputa acquire a reddish or rusty colour from the admixture of small quantities of blood. They also possess an unusual viscidity and tenacity, sometimes to such a degree that the vessel into which they are received may be inverted without their falling out; they also contain numerous minute bubbles of air, which are prevented from escaping by the consistence of the secretion.

If the disease continue unchecked, the difficulty of breathing becomes much greater, and the respirations, which in the natural state are about 20 in a minute, increase in frequency to about 40 or 60. Sometimes there is little cough throughout the disease, but most commonly it increases as the disease advances, and the sputa becomes more deeply tinged with blood. The features subsequently assume a livid appearance; the breathing gets more oppressed; expectoration is effected with difficulty; the powers of life fail, and the patient dies from the lungs being no longer able to carry on their function.

When a favourable change takes place in the course of the disease, either spontaneously, or from judicious medical treatment, it is generally attended by perspiration, the expectoration loses its rusty colour and unusual tenacity, the urine becomes turbid, and sometimes there is diarrhœa. Andral and other authors are of opinion that improvement is most likely to take place at certain times—critical days. The diagnosis of this disease has received most important assistance from auscultation, and in many instances it has been detected by its aid, where formerly it would have been overlooked. The assistance afforded by the auscultatory signs will perhaps be better understood if we defer them until we have spoken of the changes of structure in the lungs occasioned by inflammation.

In the early stage of pneumonia the inflamed part acquires an unnatural density and heaviness from the unusual accumulation of blood in it, and if a portion of lung so circumstanced be examined after death, pressure with the finger on its surface leaves an indentation which is not filled up, as would immediately be the case in a healthy state of the part. When it is cut into, a bloody frothy fluid exudes freely from it, and the surfaces present a deep blood-red colour, and if a portion be squeezed between the finger and thumb a crackling noise is heard indicating the presence of air. In a more advanced state, the lung is found still more dense, and does not crepitate when squeezed, showing that air is no longer admitted. As in this condition it somewhat resembles liver, it has been termed the stage of *hepatisation*. When the disease has proceeded still further, suppuration may be found to have taken place. Pus is then observed to be effused throughout the structure of the diseased part, by which its dull red is changed to a yellow or straw colour, and the mass is rendered soft and easily broken. Suppuration in the form of abscess very rarely occurs as a consequence of pneumonia. Laennec is of opinion that death most probably takes place before the change can have proceeded to that extent.

Auscultatory Signs.—In that stage of the disease in which there is only an accumulation of blood in the part, and whilst air is still admitted, the respiratory murmur is heard on examining the chest with the ear or stethoscope, but it is attended with a crackling sound which resembles that produced by rubbing a portion of hair between the finger and thumb near the ear, or by throwing salt into the fire; this is commonly called crepitous rattle or rhonchus, crepitous respiration or *crepitation*. A clear sound is also heard on percussing the chest.

If the disease has proceeded to the stage of hepatisation, the lung being in that part solid and impervious to air, percussion will afford only a dull sound without resonance, and the murmur attendant on respiration will be altogether wanting. Should a large bronchial tube pass near the hepatized portion, the resonance of the voice in the bronchus will be heard more distinctly than usual, on account of the solid being a better conductor of sound than the healthy lung.

When suppuration has taken place, the sound on percussion is also dull, and the natural respiratory murmur is wanting, but in its stead a loud gurgling noise is heard, resembling that produced by air passing through soap-suds, called *mucous rhonchus*. It is perhaps occasioned by pus escaping into the larger air-tubes.

Treatment.—The treatment of inflammation of the lungs must be conducted on the same general principles as inflammation occurring in any other part. The question of bleeding for the inflammation in this disease must be decided on general principles. Many practitioners avoid bleeding in this and other inflammations, unless the symptoms of dyspnœa become urgent from an embarrassment of the circulating organs. Even here the question arises, as to whether by weakening the system by bleeding, the congestion of the lungs may not be increased. At any rate all are agreed that having recourse to bleeding in all stages of this disease, is frequently a dangerous practice. The practice most generally adopted in this country is the administration of small doses of tartarised antimony and calomel every three or four hours. Leeches and cupping to the chest, with blisters, have also been found beneficial. The bowels, skin, and kidneys, should be acted on by purgatives, diaphoretics, and diuretics.

Inflammation is sometimes confined to the bronchial tubes, and is called bronchitis; it may also co-exist with pneumonia. [BRONCHITIS.]

Mortification or gangrene of the lungs, though sometimes occurring as a result of pneumonia, most frequently takes place as an independent affection. It is often connected with the tuberculous condition of the lungs. Great fetor of the breath, with an expectoration of dark-brown, greenish, and fetid sputa, excessive debility, and a cadaverous expression of countenance, are the symptoms by which it is indicated. After death portions of lung are found in a partially decomposed state, of a dark brown or dirty greenish appearance, with a putrid smell. Occasionally, under favourable circumstances, the mortified parts have been separated and removed by expectoration, and the patients restored to health; but this is not a result which can commonly be looked for. The disease has been known to occur sometimes as a consequence of working in cesspools, and of long exposure to the noxious effluvia attendant upon such occupations.

Hæmoptysis; Spitting of Blood.—Expectoration of blood may occur either by exhalation from the mucous membrane of the air-tubes or from the lesion of a blood-vessel. It generally occurs in early life, from the age of fifteen to thirty-five, and in the former instance may be dependent upon local congestion. This determination of blood to the lungs may be occasioned by the sudden suppression of some natural or accidental discharge from other parts, as in suppressed or impaired menstruation, or the arrest of an hæmorrhoidal discharge. Malformation of the chest also, by interfering with the free circulation through the lungs, or an impeded transmission of blood through the abdominal viscera, from the presence of tumours or ascites, may likewise contribute to produce it. Sometimes it appears to be dependent upon an altered condition of the blood itself, as in purpura and some eruptive fevers; but its most frequent cause is tubercular disease of the lungs, in which it may arise in an early stage from the obstruction to the circulation occasioned by the tubercles, or subsequently from the vessels participating in the ulcerative destruction. An attack of hæmoptysis should lead to an accurate examination of the chest, in order to ascertain whether tubercles exist.

A remarkable sympathy has been observed to exist between the uterus and the organs of respiration, and spitting of blood has sometimes been known to precede the appearance of the menses, and to cease entirely on their accession. Sometimes it has been found to supersede the discharge altogether, or to make up for a deficiency in its quantity.

An attack of hæmoptysis is usually preceded by certain premonitory symptoms, such as chilliness, headache, lassitude, and a quick and vibrating pulse. The patient also experiences a sensation of weight and constriction at the chest, with a feeling of heat and itching in it. The expectoration of blood is attended with cough. Sometimes the quantity brought up is very considerable, and is expelled with violence; at other times the sputa are only streaked with it. The expectorated blood is generally of a vermilion colour, and when in small quantities, it is frothy and mixed with air. When the blood comes from the stomach, it is brought up by vomiting and without cough, without the frothy appearance, and is of a dark grumous character.

Pulmonary Apoplexy.—When it happens that the blood, instead of being exhaled into the air-tubes, is effused into the parenchymatous structure of the lungs, the name of pulmonary apoplexy is given to it. One or two lobules, or a small portion of the lungs only, may be affected in this manner, the structure of the part not being broken down by it. When this is the case, hæmoptysis may not take place. Such effusions are found after death in the form of circumscribed indurated masses of a dark brown colour nearly approaching to black, and surrounded by the lung in a perfectly healthy state. Life not being immediately destroyed in such cases, time is given for the absorption of the most fluid parts of the blood, which will account for the indurated character of these deposits. When the effusion is more extensive, large portions of the substance of the lung may be torn and broken down, and hæmoptysis to a very considerable and generally immediately fatal extent takes place.

One of the most common causes of pulmonary apoplexy is disease of the heart, by which the circulation through the lungs is impeded and oppressed with blood. The causes mentioned as conducing to hæmoptysis are also common to this affection, and the symptoms are very similar. The plan of treatment in these affections is founded on the same general principles as are applicable in any case of internal hæmorrhage. [HÆMORRHAGE.]

Phthisis Pulmonalis is by far the most frequent and most fatal of all diseases of the chest. [PHTHISIS PULMONALIS.]

Malignant Diseases of Lungs.—The lungs are also subject to diseases of a specifically malignant nature, such as medullary sarcoma and melanosis; but these rarely occur as a primary affection. The medullary and melanoid matter is deposited in these organs as a secondary affection, in conjunction with its existence in other parts, and frequently in all or the majority of the organs of the body.

Black or Carbonaceous Matter in the Lungs.—A peculiar discoloration in the lungs of persons who have died after working for a long period of time in coal-mines, or in mines where gunpowder is used in large quantities for blasting masses of rock, has been observed. The lung is found of a coal-black colour throughout, though still perfectly natural in all its other characters. It also exists in connection with disease of the lung, and the expectoration of persons so affected partakes of the same colour. The cause of it seems to be doubtful; but most probably it arises from the inhalation and absorption of the carbonaceous matter existing in the atmosphere of such mines.

Bony and cartilaginous tumours have been found in the lungs, and the membrane surrounding the lungs (the pleura) is sometimes met with converted into bone; sometimes it is studded with tubercles similar to those found in the lungs of Phthisis.

For an account of inflammation of the pleura see PLEURISY.

LUPININ, a bitter non-azotised matter of unknown composition contained in lupin seed.

LUPULIN. [HOPS; HUMULUS, in NAT. HIST. DIV.]

LUPUS (the Wolf), one of the old constellations, named in Aratus and Ptolemy simply Θήριον, "the wild beast." It was not a separate constellation, but was carried in the right hand of the Centaur towards the Altar. The same description is given by Hyginus. In modern maps it is represented as a wolf transfixed by the spear of the Centaur. It is situated between Centaurus and Ara, directly under Scorpius.

The principal stars are as follows:—

Character.	No. in Catalogue of Piazzi ( ), Lacaille C.	No. in Catalogue of British Association.	Magnitude.
γ	(98)	5118	3
β	(211)	4924	4
θ	(248)	5331	4
α	1231 C	4839	4
ζ	1266 C	4987	4

LUSTRUM was the name applied to a period of five solar years among the Romans, and the termination of this period was generally marked by great religious solemnities. A purifying sacrifice, called *suovetaurilia*, was usually offered at this time by one of the censors in the Campus Martius (Liv., i. 44); and the victims consisted of a cow, a sheep, and a bull, which were led round the people three times and then slain; but this sacrifice was sometimes omitted on religious grounds. (Liv., iii. 22.) The first of these services was solemnised at Rome under King Servius, B.C. 566; the last under Vespasian, in A.D. 74. Varro ('De Ling. Lat.,' v. 2) derives the word lustrum from *luere*, because the farmers paid their taxes at that time; but others, with more probability, trace the etymology to the purifying sacrifice which was then offered.

It is well known that the most ancient Roman year consisted only of 10 months, or 304 days, and that this year continued to be used for religious purposes. Niebuhr, in his 'History of Rome,' has shown that the *lustrum* was the period after which the beginnings of the civil and religious years were made to coincide; since five solar or civil years of 365 days each, containing 1825 days, coincide with six religious years of 304 days each, containing 1824 days, with the difference of one day.

In the time of Domitian the name of *lustrum* was given to the public games which were exhibited every fifth year in honour of the Capitoline Jupiter. (Sueton., 'Domitian,' c. 4.) The poets frequently used the word for any space of five years (Hor., 'Od.,' ii. 4, 24; iv. 1–6), and sometimes confounded it with the Greek olympiad, which was only a space of four years. (Ovid, 'Pont.,' iv. 6–5; Martial, iv. 45.)

(Niebuhr's *History of Rome*, vol. i., pp. 270–280, Eng. transl.; Creuzer's *Abriss der Römischen Antiquitäten*, p. 146; and the article CENSOR in this work.)

LUTE, a musical stringed instrument with frets, one of the numerous varieties of the ancient cithara. Until towards the end of the 17th century its practice formed an essential part of a good education, but it has since been partially superseded by the guitar: nevertheless, the salaried office of *lutenist* is still continued in the Chapel Royal, though the place is a sinecure. The derivation of the word is probably to be traced to the Teutonic *lut*, whence, modified, it has passed into all the European languages, whether cognate or otherwise. The German verb *lauten*, to sound, is derived from *laute*, a lute.

We do not meet with any notice of this instrument, so named, before the time of Dante, who, ludicrously enough, compares the swelled figure of a person suffering under dropsy to the form of the lute. The shape of the body and principal or lower neck may be seen in our wood-engraving of the ARCH-LUTE. Mersenne, in his 'Harmonie Universelle' (1636), describes the lute as consisting of three parts: the *table*, made of fir; the *body* or *belly*, of the same wood, or cedar, constructed of nine convex ribs joined; and the *neck*, on which was fixed the finger-board, of hard wood, having nine frets made of cat-gut. To these is to be added the *head* or *cross*, in which the pegs or screws were placed. Thomas Mace, a celebrated teacher of the lute, in a curious work entitled 'Musick's Monument' (1676), agrees in the description given by the learned French monk, adding a great number of other particulars relative to the construction and use of the instrument: to this remarkable folio we refer those who are desirous of minute information on the subject. We shall here only state, from the same writer, that the lute had at first six strings, or rather eleven, for the five largest were doubled; but that the number was gradually increased till it reached twenty-four. He tells us that in his time a very choice instrument fetched the sum of 100*l*., which may be considered as equal to 400*l*. of our present money. [ARCH-LUTE; GUITAR.]

The notation for the lute, theorbo, &c., called the *tablature*, differed entirely from that of other instruments. "The chords," says Sir J. Hawkins, "are represented by a corresponding number of lines, and on these are marked the letters *a*, *b*, *c*, &c., which letters refer to the frets on the neck of the instrument. The time of the notes is signified by marks over the letters of a hooked-form, that answer to the minim, crotchet, &c. This is the French tablature; but the Italians, and also the Spaniards, till of late years, made use of figures instead of letters." There were many kinds of tablature, but being now obsolete and forgotten it is unnecessary to add anything further concerning them.

LUTEOCOBALTIA. [COBALT, *Ammoniacal Compounds of.*]

LUTEOGALLIC ACID, a peculiar acid extracted from nut-galls by ether.

LUTEOLIN is a non-azotised colouring principle found in the woad (*Reseda luteola*). It is volatile and crystallisable.

LUTES, in chemistry, are substances employed in various operations for closing the joints of apparatus, and especially for connecting retorts and receivers, so as to prevent the escape either of the vapour or gases generated during distillation or sublimation. The term lute is also applied to the external coating of clay and sand, or other substances, applied to glass retorts, in order that they may support a high temperature without fusing or cracking. For operations on the large scale, as the distillation of aquafortis, hydrochloric acid, &c., common plastic clay is a sufficiently good lute. Sometimes it has been recommended to use what is termed *fat lute*, but this generally only in small distillations, as of nitric acid: this lute is prepared by mixing dried and powdered pipe-clay into a paste with linseed oil; and the joint is further secured, both where this lute is used and in many other cases, by tying it over with moistened bladder.

In most operations, however, a mixture of pipe-clay and meal, as linseed meal or almond powder, is quite sufficient, when secured by bladder, for any purposes, either when acids or ammonia are to be distilled. In luting common stills, in which oils or water are merely distilled, linseed meal and water, made into a paste, form an effectual lute.

In luting, or rather coating, glass retorts, in order to enable them to sustain high temperatures, Stourbridge clay or Windsor loam mixed with tow have been used; but they require long drying, and are apt to crack. The simplest mode is that of brushing the retort over with a paste of pipe-clay and water, sifting sand upon it, drying it quickly in the ash-pit of the sand-heat, then covering it again with clay and sand, and repeating the alternate applications and drying till the coating is judged sufficiently thick.

An excellent lute for these purposes consists of a mixture of Stourbridge clay and asbestos, made into a paste with water.

LUTIDINE ($C_{14}H_9N$), an alkaloid isomeric with *toluidine*, found in bone-oil, and also formed during the distillation of cinchonine. It is a volatile oily body, lighter than water, and forms very soluble salts with most of the acids.

LYDIAN MODE. [MODE.]

LYNX, a constellation of Hevelius, situated directly in front of Ursa Major, the head of the animal being half-way between *α* Ursæ Majoris and Capella. Its principal stars are as follows:—

Character.	No. in Catalogue of Flamsteed, Piazzi ( ).	No. in Catalogue of British Association.	Magnitude.
b	2	2007	4
	38	3162	4
	40	3178	4
	(223)	3059	4

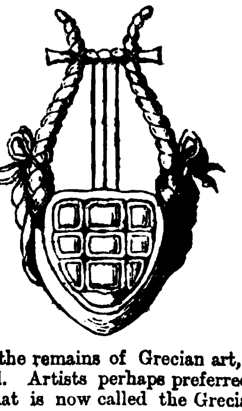
LYON KING-AT-ARMS. [HERALD.]

LYRA (the Harp), one of the old constellations, representing the lyre of Mercury (Aratus), or of Orpheus (Hyginus). It is surrounded by Cygnus, Aquila, Hercules, and the head of Draco. Its brightest star, *α* Lyræ, also called Vega, is a conspicuous object. If a line be drawn through the middle of Cassiopeia, the pole-star, and the middle of Ursa Major, this star may be seen nearly in the perpendicular to that line drawn through the pole-star. When Aquila is known, a line drawn through its four neighbouring stars, *θ*, *β*, *α*, and *γ*, will pass through *α* Lyræ. Its principal stars are as follows:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
α	3	6355	1
β	10	6429	3
δ^2	12	6466	4
γ	14	6491	3

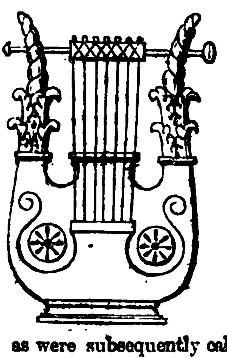
LYRE (Λύρα), a musical instrument of the stringed kind, known, under various names, from the earliest historical period. The Greeks ascribe its invention, some to Hermes, some to Apollo; but it is possible that they may have had it from the Egyptians, and the Egyptians from Asia. Indeed Holy Writ leads us to conclude that it was of antediluvian origin. Jubal, the seventh only in descent from Adam, was "father of all such as handle the harp and organ;" and as by the word *harp* we are to understand either the *lyre* itself, or some instrument analogous to it, we must, on such authority, grant to the son of Lamech the merit of being its inventor. In our version of the Scripture, *kinnor* (כנור) is rendered by the word *harp*, while the Septuagint and Vulgate give the Hebrew term a Greek form—*κιθάρα*, *cithara*, a word generally, though we believe erroneously, supposed to be synonymous with λύρα, or lyre. Erroneously, we say, because it is our opinion that lyre and cithara (or guitar) were generic terms; the first being the parent of all instruments of the harp kind, having no neck or finger-board; the last, of all those furnished with a neck, and which finger-board probably was divided by frets. [GUITAR; HARP.]

Fig. 1.



It is true that in all the remains of Grecian art, no instrument with a neck is to be found. Artists perhaps preferred the more compact and elegant form of what is now called the Grecian lyre. The same taste descended to the moderns; witness the statue of Handel formerly in Vauxhall Gardens, as Dr. Burney well remarks. Montfaucon tells us that he had examined the sculptured representations of six hundred ancient lyres and citharas, and found not one with a neck. But had the learned father—who was a most excellent and indefatigable antiquary—lived in the present day, he would have met with abundant evidence in Egypt to prove that instruments with necks—instruments of the guitar kind, such as were subsequently called *lutes*—existed at least three thousand years ago. The three-stringed guitar, says Sir J. G. Wilkinson ('Manners and Customs of the Ancient Egyptians'), was in use at the earliest period of the Egyptian history; "those at the Pyramids are apparently of a date long previous to Osirtasen, or the

Fig. 2.



arrival of Joseph." And in Rosellini's splendid work 'I Monumenti dell' Egitto e della Nubia' are many engravings, some coloured, exhibiting instruments of great antiquity, resembling in essential points the modern guitar, or lute, with a neck, but this much elongated.

The most ancient Grecian lyre—said to have been formed by Hermes from the shell of a tortoise, and of which the annexed is a representation, as given by Mersenne, had but three strings (*fig.* 1). That of Terpander (from Blanchinus) had seven, and took the form given in *fig.* 2.

Timotheus increased the number to eleven; and others were gradually added, till they reached sixteen, fifteen of which rendered the principal sounds in the Greek scale, and the sixteenth was the *Proslambanomenos*, that is, the added or supernumerary sound.

LYRIC POETRY is commonly understood to be that kind of poetry which is composed in order to musical recitation, but the epithet has been transferred to all kinds of verse partaking in any degree of the same nature as that to which it was at first applied. Thus we hear of lyrical ballads, the greater part of which might with as great propriety be called epical, and of lyric measures in Horace, where there is no ground to suppose that they were sung, and no fitness for the purpose of musical rehearsal. In a former article [EPIC POETRY] we have endeavoured to point out a distinction between epic and lyric poetry more satisfactory than common language allows; but there is surely no impropriety in giving a decided meaning to words which have usually been understood in a confused sense, particularly when, as in the present case, the same senses have been applied to each, so as not only to confuse, but to confound them. Pursuing then the course which we have pointed out, lyric poetry must be defined as that class of poetry which has reference to and is engaged in delineating the composer's own thoughts and feelings, in distinction from epic poetry, which details external circumstances and events.

The history of lyrical poetry is perhaps subject to greater difficulties than any other species of composition. In that nation where it attained to its most perfect growth, it is precisely that class of its literature which is to us, except in regard to one author, a total blank. Pindar is nearly all that remains to us of the whole lyric poetry of Greece, and great as his reputation has deservedly been, we have no reason to consider him as paramount to his class, and very good reason for denying to him what has commonly been considered his right, that of presenting us with the purest type and example of a lyric poet. And scarcely any trace remains of that link between epic and lyric poetry which was the origin of Greek tragedy. This was perhaps the most national form of lyric poetry among the Greeks, the others having been for the most part rather the productions of individual imaginations, which gained popularity in proportion as they found sympathy, much in the way in which modern poetry makes its way into notice.

Ulrici, in his very elaborate work on the history of Greek poetry, gives two as the principal sources from which lyric poetry was derived—religious worship, and the individual feelings of the people; the first of which elements is traceable in one of the two kinds of epic poetry, which we named *hieratic*, while the second is that in which consists the difference between epic and lyric poetry. He proceeds to divide Greek lyric into the Doric, Æolic, and Ionic kinds: which correspond nearly, the first to what is to be found in choruses; the second to love-songs, such as Sappho's, and drinking-songs, or scolia; and the third to the elegy, epigram, and satire.

It has been remarked that both in epic and in lyric poetry the Romans possessed nothing like a school of poets, while in Greece there was a regular progression from epic to lyric schools, each of which supplied many individuals grouped round a principal figure in each class. Virgil and Lucan are the types of Roman epic poetry, and Horace stands almost alone as a lyric poet. But to attempt to give a history of Roman lyric would be little else than to enumerate every man who wrote verses from Ennius downwards, for almost every one of them attempted that as well as all other kinds of poetry. The whole of Latin poetry was in fact on a Greek model, even the most original of the Latin poets having borrowed his metres, though he might make everything else his own.

It might perhaps startle any one to be told that satire is a branch of lyric poetry, and that the most important branch of Roman lyric is satire. But a careful review of the definition with which we started cannot fail to explain this. Satire is essentially lyrical or subjective in its nature, and the Roman satire more so than the Greek, inasmuch as it partakes far less of the nature of lampoon or ludicrous description, and deals more with general than with individual traits of character. In their satire it is that we must look for information on Roman modes of thought and feeling. It was, or at least appears to us to have been, the only outlet which the Imperial tyranny gave to the free and noble spirit of Rome in her best days, and it is quite astonishing how far this liberty was employed. What it was in earlier days we cannot tell, except as far as Horace's description of Lucilius avails. The words may mean almost anything, but we should be inclined to suppose that it partook much more of the nature of lampoon than in later times. To the satire we may add its powerful auxiliary the epigram, the same in name but very different in nature from its Greek fellow, which ought rather to be called epigraph, or even epitaph.

The Horatian lyrics merged in the later ages of the empire into a species of poetry much neglected, we mean the rhyming verses of the monks, which often contain Hebrew sublimity expressed in most sonorous verses. They are curious as affording the best specimen of the transition from scansion to accent, that is, from the antique to the modern rule of versification.

English lyrical poetry is late in its full development, for to call our ballads lyrical is a misnomer, seeing that the prose and poetical romances often give exactly the same story in another shape. We need go no further than the ballad 'Mort d'Arthur," so well known to readers of Percy's 'Reliques.' At the same time, though the form of these ballads is mostly narrative or epical, there is often a strong admixture of lyrical feeling, as in 'The Jew's Daughter,' 'Sir Cauline,' and others. Scarcely any poems occur before the time of Milton deserving the title of lyrical, except perhaps some of Giles and Phineas Fletcher's works and Shakspere's sonnets. In 'Lycidas,' 'Il Penseroso,' and 'L'Allegro,' we see almost the first, and perhaps the most beautiful examples our language can boast. The prevalence of French taste until the revival of poetry at the close of the last century gave so artificial a character to the works of Dryden, Pope, and their successors, that we can hardly give the title of lyrical to any of them except the satires and a few fine odes. In our own day Wordsworth and Coleridge are too well known to require that we should point out how exclusively lyrical is the tendency of their works. Shelley has combined more of what is called sensuous beauty with the rest of the qualities requisite to make up a lyrical poet; and, among living poets, Tennyson may perhaps be mentioned as the greatest of lyrical poets.

(Ulrici's *Geschichte der Hellenischen Dichtkunst*; Dunlop's *Hist. of Roman Literature.*)

LYRICS are those verses which are commonly used in lyrical poetry. Such are those of Pindar, of Horace's odes, and of the tragic and comic choruses. They are generally short, in order, as is said, to agree better with the time of any music which might have been intended to accompany them. The old grammarians divided all verses into those in which the metre was repeated in each line (κατὰ στίχον), such as hexameters, iambics, and trochaics; and those which require more lines than one to make up a system (κατὰ σύστημα), as in the case of Sapphic or Alcaic verses, or a choric strophe. The latter division contains almost all the lyric metres known, including nearly all Horace's odes, all Pindar's, and all the choruses and even anapæstic systems. Of these strophes a further division has been made, into *longer*, such as Pindar, Stesichorus, Simonides, and the Greek dramatists employed; and *shorter*, such as those of the earlier Ionian and Æolian poets, of their imitators, and of Seneca, besides rare examples in the Greek dramatists.

Hermann further distinguishes the longer strophes into Dorian, Æolian, and Lydian, of which he gives examples from Pindar to prove that the first was used where impressive majesty was requisite, the second to give a notion of rapidity and vehemence, and the third as possessing part of the qualities of each.

A question has arisen, and it is at all events a curious point, why lyrical poems are generally divided into lines so much shorter than heroic. That such was the case in Greek and Roman poetry is certain, and it is not explained by saying that they were sung to an accompaniment, for surely there is just as much reason to suppose that Homer's long hexameters were chanted as Anacreon's short iambics, and music might be as well adapted to one as to the other.

LYTTA. [CANTHARIDES.]

M

M is the labial letter of the liquid series. For the various forms of the characters by which it has been denoted in the chief European languages, see Alphabet.

The changes to which it is liable are chiefly as follows:—

1. *M* is interchanged with *n*. Thus *m*, at the end of Latin cases and tenses, is generally represented by an *n* in Greek. Similarly the German dative *ihm* and accusative *ihn* have been confounded in the English *him*, which is at once dative and accusative. So again the German *boden*, *busen*, *besen*, *faden*, are in English, *bottom*, *bosom*, *besom* or *broom*, *fathom*. And even in the Greek language, notwithstanding its aversion to a final *m*, inscriptions exhibit such forms as *τομ βασιλεα*, *αιθηρ μεμ φσυχας*, &c., where the nasal is modified so as to accord with the initial letter of the following word.

2. *M* with *b*. Thus in Latin, *hiems* co-exists with *hibernus*, *tumeo* with *tuber*, *glomus* with *globus*, *fama* with *fabula*. This interchange explains the form of *summus*, the superlative of *sub*, of *sumo* for *subimo*, and perhaps that of *melior*, as the comparative of *benus* or *belus*, the old form of *bonus*; whence *bene*, *bellus*, *βελτερος*, *βελτιστος*, *βεντιστος*, &c. Again *βροτος* is equivalent to *μροτος*, and so related to the Latin *mor-i* and the Sanskrit *mri*. In our own language *husband* is a corruption of *houseman*, *dominus*, the correlative of *housewife*.

3. *M* with *p*. Hence the Greek forms *ομμα*, *τετυμμαι*, &c., for *οπμα*, *τετυπμαι*, &c. So the Greek preposition *μετα* has a form *πεδα*, and the Greek *μολυβδος* is in Latin *plumbum*.

4. *M* with *v*. This is particularly the case in the Welsh language. Hence the name *Roman* was transferred into that tongue with a *v* (or rather an *f*, which is pronounced as *v*) in place of the *m*; and the Latin *amnis* is believed to be identical with the Welsh *Afon*, pronounced *Avon*. The Latin language too has *promulgare*, apparently for *provulgare*.

5. *M* with *w* probably. This interchange follows easily from the last, and is a natural step towards the next. The German *mit* seems to be identical with our own *with*. In Greek too *μια*, "one," and the particle *μεν* (which also appears to denote "one," and so to correspond to *δε*, "two," probably a corruption of *δυο*), seem to have passed through a form *ϝια*, *ϝεν*, before they became *ια* and *ἑν*. Compare the old Latin *oeno* and the English *one* as it is pronounced.

6. *M* disappearing. This appears to have been the case even at the beginning of words. See what is said above; and compare the Greek *μεχρις* with *αχρις*, *μοχλιζω* with *οχλιζω*, the Latin *manus* with the Teutonic *hand*, the Latin *mere-re* with the English *earn*. At the end of words at least, the loss of an *m* is very common, particularly after *o*. Thus the Greek and Latin verb often has the first person ending in ō, where analogy would lead to *om*; *scribo*, *τυπτω*. Compare in Latin the words *sum*, *inquam*, besides the other tenses *scribebam*, *scribam*, &c.; and in Greek the middle form *τυπτομ-αι*, *τυπτεσ-αι*, *τυπτετ-αι*, which would seem to have been formed from an old active, *τυπτομ*, *τυπτες*, *τυπτετ*, with the addition of a fixed suffix denoting *self*. In Latin all the adverbs ending in *o*, signifying *motion to*, appear to have lost an *m*, namely, *quo*, *eo*, &c. Hence *adeo*, *quoad*, occur in conjunction with a preposition which elsewhere requires an accusative. Again, an *m* has been lost in *posteā*, *anteā*, *postillā*, &c.; compare *postquam*, *antequam*, &c. Lastly, the use of *rēfert meā*, *refert Ciceronis*, *interest meā*, &c., are probably to be explained by the full forms, *rem fert meam*, *rem fert Ciceronis*, *inter rem est meam*. Such a use of *res* accords well with the phrases, *in rem meam est*, *e re tua est*.

7. *M*, like the other liquids, but not so frequently, is liable to change its position with regard to the vowel of a root. Thus in Greek the root *τεμ*, *cut*, may take the form *τμη*; and *δαμα-ω* has derivatives where the *μ* is next to the *δ*.

The letter M, or rather a symbol somewhat like it, for which modern printers have found it convenient to substitute that letter, was used by the Romans to denote a thousand. It is commonly said that this character was thus used because it is the initial of *mille*; but see Numerals.

MACE, originally a club of metal, whence it derived its name of Maçe or Maçue, and whence its diminutive Mazuelle is also derived. In a more ornamental form it is used as an ensign of authority borne before magistrates. Of this last kind is the mace placed before the Speaker of the House of Commons whilst that officer presides at the sittings of the House. When any other member presides, as in a "Committee of the whole House," the mace is laid under the table. Cromwell's direction to "remove that bauble," when he dissolved the Long Parliament, is familiar to every one. It was until lately commonly supposed, that the actual mace to which he referred, was that presented by Charles II. to the Royal Society, to be placed before the President at the meetings of the society, and without which no meeting is legal. But this has been shown to be an error by Mr. Weld, the secretary, in his 'History of the Royal Society' (vol. i. p. 150, &c.). The mace presented to the Royal Society was a new one, made for the purpose. The old mace of the House of Commons appears to have been broken, melted, and sold by order of the House, August 9, 1649.

The mace as a military weapon was peculiarly appropriated to the cavalry, and in the Bayeux tapestry several are represented in the hands of the combatants. It is not clear when the fashion of suspending them from the saddle-bow for occasional use was first introduced into Europe, but as it seems to have been borrowed from the Asiatics, we may perhaps assign it to the middle of the 13th century. Muratori observes that in a close conflict of cavalry it was exceedingly difficult to overthrow or wound powerful men in armour sitting on horseback, for their persons, being enveloped in hauberks, helmets, and other iron coverings, eluded the power of swords, darts, arrows, and such like weapons. For this reason it was usual to strike men so defended with iron maces, or to turn the attack on the horses, that by making them fall they might seize the rider; or if he tumbled on the ground, the weight of his armour might render him unable to contend with any effect.

Maces seem to have been much used from the time of Edward II., both in battles and tournaments. Meyrick says all the heavy cavalry were supplied with them in the 15th and 16th centuries, though they sometimes gave way to the short battle-axe and horseman's hammer. The invention of pistols in the reign of Henry VIII. occasioned their disuse in the time of Elizabeth.

Ellis, in his notes to the 'Fabliaux,' says the mace was a common weapon with ecclesiastics, who, in consequence of their tenures, frequently took the field, but were by a canon of the church forbidden to wield the sword.

The word Mace is sometimes used by our old writers in the sense of a *sceptre*.

MACERATION is the exposing of any substances, and generally those of vegetable origin, when reduced to coarse powder, to the action of water or any other liquid, without the assistance of heat, in which last circumstance it differs from digestion. The object of maceration is twofold; either merely to soften the parts of the substance operated on, so as to allow of the more ready subsequent action of heat, as when cinnamon or cloves are macerated in water, previously to distillation; or it is employed to dissolve the aromatic parts of a substance, when digestion would not merely dissolve but dissipate them.

MACHICOLATION (in French *Machécoulis*, or *Machicoulis*). This term, which is obviously derived from the two French words *mèches* and *couler*—to pour down ignited materials—afterwards compounded into the barbarously Latinized one *maschicolatum*, or *macchicolatum*, was significantly bestowed on those openings in the parapet of a fortified building through which ignited combustibles (*mèches*), or melted lead, stones, &c., were poured and hurled down upon the besiegers. The apertures were formed in the soffit or under surface of the projecting parapet, which was supported upon corbel stones, the perforations themselves being in the soffit, between those stones. By this ingenious contrivance the besieged were enabled to harass their assailants in a most formidable manner, while they themselves were protected by the parapet and its battlements. Machicolations were frequently confined to particular situations, such as over an entrance gateway and the towers flanking it, or other parts most likely to be assaulted.

MACHINE, an object by the intervention of which a motive power is made to act upon any body and overcome the force by which the latter resists the effort to change its state of rest or motion. A machine differs in no respect from a *tool*, an *instrument*, or an *engine*, and any one of these terms might be used indifferently for the same thing: the word tool is, however, generally applied to an object containing in its construction some mechanical power, and which, when in use, is held in the hand of the operator.

The advantage which any machine affords for overcoming resistance, consists in the reaction by which it supports a certain portion of the weight producing that resistance, so that the motive power has only to counteract the remainder. This may be immediately observed in those simple machines called the *mechanical powers*. For example: in the lever, the wheel and axle, and the pulley, the properties of which depend on the theory of parallel forces (when, consequently, of the resistance, the moving power, and the reaction of the machine, some one is equal to the sum of the two others), any convenient portion of the resistance may be made to rest on the point of support, or the point of suspension. Again; in the inclined plane, the wedge, and the screw, the properties of which depend on the theory of forces concurring in a point, the motive power, the resistance, and the reaction of the support, are represented by the three sides of a triangle; and the ratio of the first to either of the others may be varied at pleasure by the construction of the machine.

The powers employed to give motion, through machinery, to any object, are produced by the *muscular strength* of men or animals; the actions of *weights*, *springs*, *wind*, *water*, *steam*, or fired *gunpowder;* and these powers may generally be considered as pressures exerted during certain portions of time. Even that power which is produced by a sudden impulse, as when a rammer descending by its weight falls on the head of a pile, is only a pressure existing during an indefinitely short interval of time. The point in any machine to which the moving power is applied is called the *impelled*, and that against which the resistance acts is called the *working* point.

In the employment of any machine a certain portion of the power is expended in overcoming the inertia and friction of the materials, and that which remains is the only efficient force by which the useful effect is to be obtained. Thus, in pushing or drawing a body up an inclined plane, the effective motive power is less than that which is actually expended by as much as is necessary to overcome the inertia of the body and its friction on the plane; and these might be avoided if it were possible or convenient to raise the body vertically to an equal height by the descent of a body of greater weight, when both are connected together by a string passing over a pulley. The loss of power from inertia is doubled when a reciprocating motion exists in the same machine; for a momentary state of rest takes place between every two contrary directions of the movement, and immediately afterwards a new inertia is to be overcome. The retarding forces above mentioned are evidently greater as the quantity of machinery in an engine is augmented; and hence every machine should be as simple as possible consistently with the requisite relation between the moving power and the opposing resistance.

In the construction of machinery it is evident that all abrupt variations of velocity should be prevented, on account of the irregularity which they induce in the action. When, for example, one wheel drives another by means of the teeth on their circumference, the pressure of the teeth takes place wholly on one side of the latter, and the movement may be steady if the teeth are well formed; but on a sudden diminution of the velocity of the driving-wheel, that which is driven, continuing for a time to move with its actual velocity, tends further to retard the movement of the other, and the pressure of the teeth against each other takes place on the opposite side. Thus a shaking motion is produced which diminishes the efficacy of the machine. The disadvantage attending such variations in the movement of the machinery renders it advisable to gain the required effect by continued pressure, if possible, rather than by the employment of percussive forces.

It is also a maxim assented to by engineers that the impelled point of a machine should not be allowed to move with a greater velocity than that with which the motive power can act upon it; since in this case the excess of velocity in the machine will be employed in accelerating the motion of the power, and thus the general acceleration of the machine will suffer a corresponding diminution. The velocities of the impelled and working points should therefore be properly adjusted to the pressures, the inertia, and the friction, in order that all possible advantage may be derived from the machine.

A just estimate of the power of a machine ought to include the effects of all the momentary accelerations and retardations of motion to which it is subject, and all the losses arising from inertia and friction; but as the introduction of these circumstances would excessively complicate the investigation, it is usual to make the measure of the power depend on the condition that the impelled and working points shall be in a state of uniform motion. For then, agreeably to the property of the simple lever, the velocities of those extreme points will be inversely proportional to the forces which would be in equilibrio at the same points; and the rule propounded by Euler is, that in every machine, simple or complex, the pressure at the impelled point, multiplied by the velocity of that point, is equal to the product of the resistance at the working point by the velocity of the same point; or the momentum of resistance (commonly called the *performance* of the machine) is equal to the momentum of impulse. Whatever objection may be made to this rule with respect to the measure of the power in action, no doubt can exist that it affords a correct value of the useful effect; and the latter may therefore be measured by the weight which might be raised by the machine to a given height vertically in a given time. The fact is sufficiently evident when a mass of any material is to be conveyed from one place to another, or when a body is let fall on any object from a given height. It follows that, if an algebraical expression be obtained for the momentum of the resistance in terms involving that resistance, the motive power and the distances of their points of application from the axis of motion, on making the differential of that expression equal to zero, the ratio of the resistance to the moving power, when the useful effect of the machine is a maximum, may be found from the resulting equation.

If M represent the mass of any body moved, W its weight, which is equal to Mg, g $(=32\frac{1}{6}$ feet) expressing the force of gravity; also, if H be the height to which the body may be raised in one second of time, and V the velocity which a body would acquire by falling vertically through a height equal to H, we shall have, by the theory of motions, $V^2=2gH$; whence WH (the momentum of resistance, or the useful effect of a machine) $=\frac{1}{2}MV^2$. This last expression is designated the *living*, or *active*, *force* of the body moved; and it expresses the force of a body in motion, in contradistinction to the simple pressure exercised by a body at rest.

It is commonly asserted that, in the employment of machinery, as much is lost in time as is gained in power, or that the momentum of resistance is proportional to the power employed; but this rule requires some modification. It can be shown to hold good in a well-constructed machine when the object moved resists by its inertia only; but if the inertia is but a small part of the resistance, the momentum of the latter, or the work done, is found to increase nearly as the square of the power employed.

The various ingenious contrivances which have been adopted in machines for regulating the velocities, and for converting one species of motion into another, are noticed in the article WHEELS.

In investigating the relations between the motive powers and resistances to be overcome, which render the effect produced a maximum with respect to quantity of motion or velocity, or which render the time of the performance a minimum, it is usual to consider that in every machine there is a certain point at which, if the moving power were immediately applied, and a certain point at which, if the resistance to be overcome were immediately applied, the effect produced would be the same as that which is produced by the machine in its actual state. Thus, in a machine consisting of several wheels and axles with which weights are raised by means of ropes passing over their circumferences, the points at which the ropes immediately connected with the moving power and resistance are tangents to the circumferences are those at which the forces are conceived to be applied. Also, if several forces act at once as moving powers, and resistances are to be overcome at once at various points, the resultant of all the forces and that of all the resistances must be taken for the effective moving power and the effective resistance. The points of application of these resultant forces are to be found, and at these points such resultant forces are conceived to be applied: the effects of friction, the rigidity of ropes, and every other impediment to the action of the machine, are also to be estimated and applied as additions to the resistance which is to be overcome; and thus a complex machine is reduced to an equivalent mechanical power of a simple form. The velocities of the points at which these resultant forces are conceived to be applied are equal to the velocities of the power and resistance.

The motion in machines may be of two kinds. On the application of force to a machine previously at rest a certain movement is induced, and this movement for a time is accelerative; but in some machines, after a while, the resisting power and the friction of the materials destroy the acceleration, when, unless the machine is subject to variations of force, as is the case with those which are impelled by the wind or by the force of men or animals, the movement will become uniform. On the other hand, there are machines which are acted on by a constantly accelerative power, as when a weight at one end of a rope passing over a wheel descends from an elevated place and raises a weight attached to the other extremity.

If the velocities of the points of application of the equivalent forces are uniform, a simple equation will express the dynamical equilibrium of the machine; for, F representing the moving power, and V the velocity with which it moves, f the force of resistance and v its velocity, we have in the case of equilibrium

$$FV=fv;$$

the first member of the equation is frequently designated the *momentum of impulse*, and the second the *effect* produced by the machine.

But the effect of a moving power on a machine in motion is different from that of an equal power on a machine at rest; for the effect produced by any constant power in the former case depends upon its relative velocity, or the difference between its own velocity and that of the machine, and, by dynamics, it varies with the square of the relative velocity. Therefore, in order to introduce the absolute effect of a force into the equation of equilibrum in place of the efficient force, there must be given the velocity which would render the force quite ineffectual, as well as the actual velocity of the point of application: let the former be represented by V', and the latter by V; than F' representing the absolute force when the velocity is zero, and F the actual force when the velocity is V (F' being determined by the weight or resistance which is just sufficient to prevent the power from communicating motion to the machine, and V' by the velocity with which the machine can move when the resistance is zero),

$$F' : F :: V'^2 : (V'-V)^2;$$

whence $F=F'.\dfrac{(V'-V)^2}{V'^2}$.

Then the first member of the equation $FV=fv$ becomes

$$F'\frac{(V'-V)^2}{V'^2}.V:$$

or, putting v' for $V'-V$, which gives $V=V'-v'$, it becomes

$$F'\left(\frac{v'}{V'}\right)^2(V'-v')$$

Now, in order to find the velocity which is consistent with the production of the greatest effect by the machine, this expression, which represents the equivalent of fv, the efficient action of the machine, is to be a maximum; therefore, differentiating that expression, v' being the variable, and making the result zero, we have

$$2\mathrm{v}' - 3v' = 0; \quad \text{whence} \quad v' = \frac{2}{3}\mathrm{v}'$$

and, by substitution, $\mathrm{v} = \frac{1}{3}\mathrm{v}'$.

Hence, if the resistance opposed to the machine is susceptible of being varied, it should be rendered such that the velocity v of the point of application of the equivalent force is one-third of the greatest velocity v′ which the power can produce if unresisted. Substituting this value of v in the above equation for F we get $\mathrm{F} = \frac{4}{9}\mathrm{F}'$; therefore F v, the momentum of impulse, or the effect of the machine, becomes $\frac{4}{27}\mathrm{F}'\mathrm{v}'$ when that effect is a maximum, the resistance remaining unaltered.

If two bodies are connected together by a flexible line (supposed to be without weight) passing over a pulley at the common summit of a doubly inclined plane, the parts of the line being parallel to the surfaces of the two planes; the relation between the weights may be determined so that the momentum of that which is to be raised by the descent of the other may be a maximum. Let p and w be the weights of the bodies, or the forces of gravity acting on them vertically, and let θ and θ' be the respective inclinations of the planes on which they are placed, to the horizon; then p sin. θ and w sin. θ' are the forces of gravity on the planes, and consequently $\frac{p \sin\theta - w \sin\theta'}{p+w}$ is the accelerative force by which p descends.

Now, by dynamics, the velocity of a body varies with the force and time; therefore, v representing the velocity of p or w, and t the time of motion,

$$v \propto \frac{p \sin\theta - w \sin\theta'}{p+w}\, t,$$

and consequently the momentum wv varies with

$$\frac{pw \sin\theta - w^2 \sin\theta}{p+w}\, t:$$

this expression is to be a maximum; therefore, differentiating it, w being the variable, and making the result equal to zero, the value of w may be found in terms of p by a quadratic equation: thus, the required relation may be obtained.

If it were required to find, in any machine which when reduced to its most simple state may be considered as a lever or a wheel and axle, the ratio of the velocity of the moving power to that of the resistance to be overcome when the latter is a maximum, the following process may be used.

Let the arms of the supposed lever, or the semi-diameters of the supposed wheel and axle, be represented by r and r', the power p being applied at the extremity of r, and the resistance w at that of r'. By the nature of the lever, $p = \frac{wr'}{r}$ in the case of equilibrium; therefore, when the power is such as to produce motion, the motive force may be expressed by $p' - \frac{wr'}{r}$ if applied at the extremity of r. Now, in order that the momentum of the inertia of w at a distance r' from the fulcrum may be made equivalent to the momentum of inertia of a body at a distance r, on representing such body by p'', we have $p''r^2 = wr'^2$; whence $p'' = \frac{wr'^2}{r^2}$: the whole inertia to be overcome, if applied at a distance r from the fulcrum, will therefore be $p + \frac{wr'^2}{r^2}$, and the accelerative force at the extremity of r will be

$$\frac{p + \frac{wr}{r}}{p + \frac{wr'^2}{r^2}} \quad \text{or} \quad \frac{r^2p - wrr}{r^2p + wr'^2}.$$

But, by dynamics, the velocity of a body varies with the force and time; therefore, representing the velocity at the end of the arm r by v,

$$v \propto \frac{r^2p - wrr}{r^2p + wr'^2}\, t:$$

in order to obtain the velocity at the end of the arm r, the expression for v must be reduced in the ratio of r to r'; therefore the velocity at the latter extremity varies with

$$\frac{rr'p - r'^2w}{r^2p + wr'^2}\, t.$$

This expression is to be a maximum; therefore, on differentiating it, r' being the variable, and making the result equal to zero, there will be obtained the ratio of r to r' (which is the same as that of the velocities of p and w) consistently with the condition that the velocity of w is a maximum.

In the theory of machines, the modification of motion and the modification of force take place together, and are connected by certain laws; but in the study of the subject there is an advantage in first considering the principles of the modification of motion, which are based upon a branch of geometry called *cinematics*, and afterwards considering the principles of the combined modification of motion and force, which are founded both on geometry and on the laws of dynamics. The separation of cinematics from dynamics is due mainly to Monge, Ampère, and Willis. The modern view of the subject of applied mechanics may be best studied in the following works: Poncelet, 'Mécanique Industrielle;' Morin, 'Notions Fondamentales de Mécanique;' Willis, 'On the Principles of Mechanism;' Moseley, 'Mechanics of Engineering and Architecture;' Whewell, 'Mechanics of Engineering;' Rankine, 'On Applied Mechanics,' and on 'Prime Movers.'

MACHINERY. It is proposed to consider in this article the influence which is exercised by machinery upon the general interests of mankind, and especially upon the well-being of different classes of society. There is no subject in the present age which is more deserving of attention; and none perhaps in which all classes are so much concerned. Whatever theoretical opinions may be entertained by speculative men, the use of machinery in aid of human labour, or, as some contend, instead of it, is rapidly increasing and cannot be restrained; it is right therefore for all men to endeavour to judge for themselves in what manner it is valuable to society, and whether the injuries attributed to it be real or imaginary. By some, every new machine is viewed as an addition to the wealth and resources of a country; by others it is regarded as a hateful rival of human industry—as iron contending with straining sinews—as steam struggling against the life and blood of man. The one view is full of hope and promise; the other is fraught with gloom and sadness. One would present society advancing in wealth and comfort; the other would show it descending faster and faster into wretchedness. But even those who believe that the inventive faculties of men have been engaged in devising for themselves a curse, would gladly be convinced that cheerful anticipations of good are consistent with sound philosophy.

The influence of machinery is of two kinds; 1st, as it affects the production and consumption of commodities; and 2ndly, as it affects the employment of labour.

As regards production, the effects of machinery have been well described to be the same "as if every man among us had become suddenly much stronger and more industrious." ('Results of Machinery,' 7th edit. p. 36.) If, by the aid of machinery, ten men can perform the work of twenty, and perform it better and more quickly, the products of their labour are as much increased as if they had really "become suddenly much stronger and more industrious," and, it may be added, more skilful. Thus production, which is the object of all labour, is more abundant, and society enjoys the results of industry at a less cost. Who can doubt that this is a great benefit, unless it be attended with evils which are not at first perceptible? No man labours more than is necessary to effect his object, and his constant desire is to contrive modes of saving his own physical exertions. A rich soil and a fine climate are universally esteemed as blessings because the people enjoy abundance with comparatively little labour. A poor soil and bad climate are evils, because the husbandman must labour much, though the produce of his industry be small.

Labour without adequate results is always regarded as a curse, and almost every human invention, from the earliest times, has had for its objects the saving of labour and the increase of production. Horses and other beasts of burden were made to work for man; to bear loads which otherwise they must have borne themselves; to draw the plough which otherwise their own strength must have forced through the soil. To the same object all nature has been made subservient. The stream turns the mill, and does the work of man; the wind performs the same office. A boat is built to save men the labour of carrying their goods to a distance, and it is less labour to row the boat than to carry its cargo: but rowing is laborious, and sails were invented that the wind should do the work of man. In all other matters it has been the same. Man is weak in body, and ill endowed by nature with the means of self-preservation and subsistence. Many animals are stronger and most animals are more active than himself: they can pursue their prey with more certainty, they are armed with weapons of offence and defence, and they need no shelter from the weather but that which nature has provided; their own powers and their own instinct suffice for their preservation. But man was created naked and defenceless. To live he must invent, and reason was given to him that he might force all nature into his service. His teeth and nails were powerless against the fangs and claws of the wild beast; but his hands were formed with wondrous aptitude for executing the tasks which reason set them. He invented tools and implements and weapons, and all nature became his slave. He was now able to make his own strength effect as much as if he had become stronger and more industrious. He produced more for his own comfort and subsistence, with little labour, than the greatest exertions could otherwise have obtained for him. Every successive invention has made him more powerful, has increased his strength, and multiplied the productions of his industry; and at length the giant power of steam has peopled the world with inanimate slaves, who do his work faster and better than he did it himself with the greatest labour and the most ingenious tools.

The flint and fish-bone of the savage, the tool of the workman, and the steam-engine of the manufacturer, have but one common object—to save the labour of man and to render it more productive: but that is the most perfect invention which attains this object the most effectually. Can any one doubt the advantage of abundant production? It needs but a few words to point out its benefit. Whether it be for evil or for good, we are not satisfied with the enjoyment of the common necessaries of life; we all desire comforts, luxuries, and ornament; and in proportion as we desire them do we become civilised. There are many who sneer at civilisation, and unhappily it has its vices, its follies, and its absurdities; but it seems the law of our nature to advance to that state, and with the increase of artificial wants our intellects become more active and enlightened, refinement of manners succeeds to barbarism, and all those moral qualities for which man is distinguished, become developed. We may conceive some Utopia in which all the noble parts of man's nature are cultivated, while his wants remain simple and easily satisfied, but the world we live in presents another picture. We might wish it were otherwise; but it is in vain to deny that refinement is the accompaniment and, in some degree, the consequence of riches, and brutality the condition of those people who have not been elevated by the increase of wealth. It follows therefore, that to multiply the objects of comfort and enjoyment which human industry can produce, is to improve the condition of mankind, to raise them in the scale of moral and intellectual being, and to minister to their enjoyment of life. It is quite consistent to deprecate the vices and follies which are ever associated with our craving for new possessions, while we observe the benefits resulting from the desire to progress in improvement. Throughout the world good and evil are found side by side; but the good, as we would fain believe, preponderates.

When once it is admitted that men are to be decently housed and clothed, and are to surround themselves with such comforts as they can obtain, it is clear that the more easily they can obtain them, and the more generally such possessions are enjoyed, the more completely are the objects of civilised life secured. If all men could obtain them easily, there would be no poverty, and infinitely less vice. Machinery, by diminishing the amount of labour required for the production of commodities, lowers their price and renders them more universally accessible to all classes of society. Working-men no longer toil for the rich alone, but they participate in the results of their own industry. If they desire such luxuries, "purple and fine linen" are not beyond their reach; and their dwellings are more commodious and often more elegant than were the houses of the rich three centuries ago. If this increased facility of acquiring the comforts of life had been accompanied by greater prudence and frugality, we believe that the beneficial results of machinery would have been conspicuously shown by the improved condition of all the working-classes of this country. Cheap production is more beneficial to the poor than to the rich. The rich man is certain of gratifying most of his wants, but the poor man is constantly obliged to forego one enjoyment in order to obtain another. If his shoes or his coat be worn out, his dinners must be stinted perhaps until he can pay for a fresh supply; and thus, unless his wages be reduced in consequence of the cheapness of such articles, it is beyond all question that cheapness is an extraordinary benefit to him, the money which he saves in the purchase of one cheap article is laid out upon another, and without privation or suffering he satisfies the wants which custom has made imperative. In short he is no longer poor.

These facts are undeniable; but it is alleged that machinery not only makes articles abundant and cheap, but multiplies them beyond the wants of the world, and by causing gluts brings ruin and misery upon the working classes. For reasons explained elsewhere [DEMAND AND SUPPLY] a universal glut of all commodities is impossible: the more men produce, the more they have to offer in exchange, and their wants are only limited by their means of purchasing. But particular commodities are frequently produced in excess, and a glut of the market ensues. In causing such gluts machinery is a powerful agent, but only in the same manner as all labour would be, if applied in excess. The results would be precisely the same if too many men were employed in any department of industry; they would produce more than there was a demand for, and their goods would fall in value or be unsaleable. Commodities produced by machinery are subject to the same laws as govern all other commodities. If the supply of them exceed the demand, they are depreciated in value; but the power of producing with facility does not necessarily occasion an excess of production: it must be applied with caution, and its use be properly learned by experience. Suppose that the soil of any isolated country were extraordinarily fertile and the population very small; but that without considering these circumstances the people were to cultivate the whole of their land and bestow upon it all their skill and labour. An excess of food would be the result—more than could be eaten within the year; much would be wasted or sold without profit, and much laid up in store for another season. The husbandmen would be disappointed at the unfortunate results of their industry, but would they complain of the fertility of the soil? It would not be the soil that had caused the glut, but their own misapplied exertions; and so it is with machinery, which like a fertile soil gives forth abundance: its capabilities are known and its advantages ought to be appreciated; but if its productiveness be brought into excessive activity, it causes the evils of a glut.

The influence of machinery upon the production and consumption of commodities need not be followed any further. It increases the common stock of wealth in the world and is capable of multiplying indefinitely the sources of human enjoyment. But these benefits will be neutralised if, while it cheapens production, it has a tendency to diminish the means of employment for the people, and lower the wages of labour;—and this leads us to the second part of our inquiry.

The invention of a machine which should immediately do the work of many men employed in a particular trade would certainly, in the first instance, diminish employment in that trade. Several men would be turned off to seek employment in other trades, and much individual suffering would be occasioned. There have been frequent instances of such a result, and so far as the immediate interests of the particular sufferers are concerned, it is an evil which cannot be too much lamented. In their case machinery is like a rival bidding against their labour, and is as injurious to them as if a fresh set of workmen had supplanted them in the service of their employer. But great as this evil is (and we would not underrate it) it is of comparatively rare occurrence and of short duration. If the invention of the machine caused no more production than the labour of the workmen had previously accomplished, the labour of a certain number of men would be permanently displaced: but as an equal quantity of goods is produced at a less cost of labour, their price is reduced, and their consumption consequently encouraged. An increased supply is thus called for, and more workmen are again required in the trade. In this manner the demand for increased production corrects the tendency which machinery would otherwise have to displace labour permanently. Even the temporary displacement which frequently occurs is less extensive than might be supposed. Machines are rarely invented which at once dispense with many workmen. They are at first imperfect, and of limited power: they make the labour of the workmen more efficient: but do not become substitutes for labour. Thus, even if the demand for commodities were not increased, the displacement of labour would be very limited and deferred to a distant period: but as an increased demand almost invariably follows every successive improvement in machinery, it will be found, practically, that more operatives are employed in every branch of manufacture, after the introduction of improved machinery than before.

Of this fact we shall offer some examples presently; but here it may be necessary to allude to the case of the hand-loom weavers, which is constantly adduced in proof of the supposed evils of machinery. Their unhappy condition can scarcely be overstated, nor can it be denied that it has been caused by machinery: but it must be recollected that while they have vainly contended against machinery—like pigmies against a giant—hundreds of thousands of other classes, unaccustomed to the labour of operatives, have gained a profitable employment by working *with* it, in the same trade as themselves. No one can suppose that the labour of the hands could compete with the power of steam, and the real cause of their distress is, that instead of adapting the form of their industry to the altered circumstances of their trade, they have continued to work, like an Indian caste, with the same rude implements which their fathers used before them. Their case is the same as that of a miller who should persist in grinding corn by hand, while his neighbours were building mills upon a rapid stream which ran beside his garden. His own ignorance or obstinacy, and not the water-wheel, would be the cause of the failure of his trade.

If the case of the hand-loom weavers be adduced as an example of the permanent displacement of labour by machinery, and if it be contended that it is the natural result of machinery to diminish employment in other trades in the same manner, we must necessarily infer that wherever machinery has been largely introduced into any trade, the number of persons supported by it must have been diminished. We should infer that the agricultural population of this country must have been rapidly increasing, while the population engaged in those branches of manufacture in which steam-power is used must have been falling off or increasing less rapidly. The correctness of such an inference may be estimated from the following facts:—

In no trades has machinery been so extensively introduced as in the manufacture of cotton, wool, and silk, and nowhere has the population increased so rapidly as in the principal seats of these manufactures. The census returns of 1801, 1841, and 1851, show the following remarkable increase of population in some of the chief manufacturing boroughs, in which the borough boundary is taken:—Manchester, from 90,399 to 240,367, and, with Salford in 1851, to 401,231; Liverpool, (whose prosperity depends mainly on the cotton trade) from 79,722, to 282,656, and 375,955; Stockport, from 19,250 in 1811, to 50,154 and 53,835; Leeds, from 53,162 to 151,063, and 172,270; Bradford (Yorkshire) from 6393 to 66,508 and 103,778; Bolton, from 17,416 to 50,163 and 61,171; Huddersfield, from 7268 to 24,931 and 30,880; and Macclesfield, from 8743 to 32,523 and 39,048. In Scotland the same results have followed from the use of machinery. The population of Glasgow increased from 77,058 to 261,004 and 329,097; Dundee, from 27,396, to 64,629 and 78,931; and Greenock from 17,458 to 36,936 and (the parliamentary borough only) 36,689.

Thus far of the manufactures of cotton, wool, and silk. The seats of the iron and hardware trades exhibit similar results. In the same periods Birmingham increased from 73,670 to 181,116 and 232,841; Sheffield, from 31,314 to 109,597 and 135,310; Wolverhampton, from

12,565 to 92,943 and 119,748; Merthyr Tydvil, from 7705 to 34,977 and 63,080; and West Bromwich from 5687 to 26,121 and 34,591.

A large extension of employment in any one branch, necessarily produces accessions in most others. It may therefore be not uninteresting to state the number of persons directly engaged in the staple employment of the towns named. In Manchester and Salford, 65,000 are engaged in the manufacture of cotton, silk, and wool; at Stockport, 17,000, cotton; at Leeds, wool and flax, 23,714; at Bradford, worsted and stuff, 33,000; at Bolton, cotton, 14,500; at Huddersfield, woollen cloth, 13,935; Macclesfield, silk, 14,500; Glasgow, where the employments are more miscellaneous, cotton and flax give employment to only 14,830 persons; Dundee, in linen and flax, 19,742. The various metal trades employ in Birmingham, 26,900; in Sheffield, 20,000; in Wolverhampton, 10,530; Merthyr Tydvil, 13,412; and West Bromwich, 7032; in the last-named three the coal-miners are included.

In this extraordinary ratio has the population increased in the seats of our staple manufactures, which by the aid of machinery have supplied the whole world with articles wrought by the industry of our people. Let us now compare these places with those agricultural counties in which machinery has exercised the least influence, and let us see if the absence of machinery has been equally favourable to the support of a growing population. In the same period, Devonshire, Somersetshire, Dorsetshire, Norfolk, Suffolk, Essex, and Lincolnshire, have increased on an average little above 50 per cent.; while, setting aside the extraordinary increase exhibited in the particular towns already enumerated, the population of six manufacturing counties, viz. Lancaster, Middlesex, York (W. R.), Stafford, Chester, and Durham, including all the agriculturists, increased nearly 120 per cent.

These facts prove conclusively that machinery, so far from diminishing the aggregate employment of labour in those trades in which it is used, increases it in an extraordinary degree. And not only does it give employment to larger numbers of persons, but their wages are considerably higher. We will not stop to compare the income of an agricultural labourer with that of operatives engaged in the infinite variety of trades carried on in manufacturing towns, in connection with machinery: but it is sufficient to ask, whence has come the manufacturing population? Its natural growth would have been comparatively insignificant if thousands had not been attracted to the towns from other places. And what could have induced them to leave their homes and engage in new trades but the encouragement offered by more certain employment and higher wages?

It has been shown that machinery has had a beneficial influence upon the employment of labour in the particular trades in which it has been used, and it now remains to consider its effects upon the employment of labour in other trades. In the first place, a few of its obvious results may be noticed. For example, the manufacture and repair of machinery alone gives employment, directly and indirectly, to vast numbers of persons who are unconnected with the particular trades in which the machinery itself is used. Again, the production of all commodities is increased by machinery; and thus the producers of the raw materials of manufactures, the carriers of goods by land and sea, the merchants, the retail-dealers, their clerks, porters, and others, must find more employment. It is clear also, that while the manufacturing and commercial population are thus increased by the use of machinery, the cultivators of the soil must receive more employment in supplying them with food.

In this and other ways the general employment of labour is directly extended by machinery. At the same time the application of machinery to existing branches of industry creates new trades and distributes capital into other enterprises which afford employment for new descriptions of labour. A hundred examples of this fact might be cited; of which railways and steam navigation are amongst the most remarkable; but such examples will be superfluous if it can be shown that it is the necessary result of the use of machinery to apply capital to new enterprises. It has been said that machinery cheapens production by reducing the amount of labour expended upon it: it follows that a less amount of capital with the aid of machinery will produce as much as a larger capital without such aid. A portion of capital is thus disengaged, either for increased production in the same trade, or for application to new speculations. In some way it must be employed, or it will yield no profit, and in some form or other it must be ultimately expended in labour. As long as a person can extend the accustomed operations of his own trade with a profit, he is disposed to do so; but as soon as he finds them less profitable than other investments, he changes the direction of his capital, and seeks new modes of increasing his profits.

There is no truth more certain than that the employment of labour is small or great according to the proportion which capital bears to the number of labourers. Capital is the fund which supports labour, and which must employ it or be unproductive; and thus, if in any country capital be increasing more rapidly than the population, employment will be abundant and wages high; if less rapidly, employment will be scarce and wages low. In the one case, capitalists will be bidding high for labour; in the other, labourers will be bidding against each other for employment. Accumulation of capital is therefore highly conducive to the interests of the labouring population generally, and the use of machinery is especially favourable to accumulation, as may be shown by a simple example. Suppose a man to have a capital of 10,000*l.*, which he is expending annually upon labour in a particular trade, and that his profits are 10 per cent., or 1000*l.* a-year. Each year his whole capital is expended, and his means of accumulation are thus restricted to a portion of his annual profits only. But let him invent a machine to facilitate his business, and his position is immediately changed. If this machine should cost 5000*l.*, and the other 5000*l.* be still expended in labour, he may be said to have saved one half of his entire capital in a single year; for instead of spending the whole of it as before, in labour, he is possessed of a durable property which, at a small annual cost, will last for ten or probably twenty years. Nor can it be said that this saving is effected at the expense of labour; for the owner of the machine is placed in a new position in respect to his profits, which prevents him from securing to himself the difference between the amount paid now and that previously paid for labour. To gain a profit of 10 per cent. it had been necessary for him, before the invention of the machine, to realise 11,000*l.* annually, being his whole capital and the profits upon it: but now, in order to obtain the same profit, it is sufficient if he realise 6500*l.* only: namely, 500*l.* profit upon his fixed capital of 5000*l.*; 500*l.* for repairs, and wear and tear, calculated at 10 per cent.; and 5500*l.* to replace the sum spent upon labour, with a profit of 10 per cent. He would realise the whole 11,000*l.* as before, if he were able; but he is restrained by competition, which levels the profits of trade. For some time he will most probably obtain more than 10 per cent. profit, and so long as he is able to do this, his means of accumulating fresh capital in addition to his machine will be increased, which capital will be expended upon additional labour. But when his profits had been reduced to their former level by competition, society has gained in the price of his goods 4500*l.* a-year, being the difference between 11,000*l.* formerly realised by him, and 6500*l.* his present return. But is this amount thus gained by society lost to the labourer? Unquestionably not. As a consumer, he participates in the advantage of low prices, while the amount saved by the community in the purchase of one commodity must be expended upon others which can only be produced by labour. It cannot be too often repeated, that all capital is ultimately expended upon labour; and whether it be accumulated by individuals in large sums, or distributed in small portions throughout the community, directly or indirectly it passes through the hands of those who labour. If a manufacturer accumulates by means of higher profits, he employs more labour; if the community save by low prices, they employ more labour in other forms. So long as the capital is in existence, it is certain to have an influence upon the general market for labour.

We are now speaking not of the interests of particular workmen to whose temporary sufferings caused by the use of machinery we have already adverted, but of the general and permanent interests of the working population of a country. As regards these, the statistics of British industry amply confirm all reasoning from principles, and prove beyond a doubt that machinery has had a beneficial influence upon the employment and wages of labour. Any one who will reflect upon the facts which have been noticed above, as disclosed by the Census [CENSUS], can scarcely fail to arrive at the conclusion that without machinery England could not have supported her present population, or could only have supported them in poverty and wretchedness. Nor must the degradation of a part of the manufacturing population be thoughtlessly attributed to machinery, instead of to moral and social causes, which are independent of it. Into these causes it would be out of place, at present, to inquire; but enough has been said to show, 1st, that machinery by increasing production multiplies the sources of enjoyment, and places them within the reach of a greater number of persons; and 2ndly, that by giving increased employment to labour it enables more persons to enjoy those comforts which it has itself created. These are the elements of social prosperity, and if evils have sprung up with it, like tares with wheat, it is not machinery which has caused them. Wherever the influence of machinery has been felt, wealth has advanced with rapid strides; and though in too many cases religion, virtue, and enlightenment may have lagged behind, the tardiness of their progress is to be ascribed, not to machinery, but to the faulty institutions of men.

MACHINERY, COMPOSITION OF. The composition of a machine is usually understood, by writers on this branch of the arts, to involve all the detailed arrangements by which the power exerted, however that power be obtained, is made to produce the required effects; or in other words, those contrivances by which the initial force is transmitted with the smallest loss, or with the least waste of material. From the endless modifications of machinery it must evidently be impossible here to notice all their component parts; but a few general observations upon wheels, shafts and spindles, cranks and excentrics, drums and band wheels, clutches and coupling-gearing, may suffice to call attention to some of the leading principles connected with the composition of machinery.

Wheelwork, whereby the power is transmitted by means of teeth working into one another, is usually known under the name of gearing, and this part of the subject has already been noticed [GEARING]; but it may perhaps be worth while to add that wheels are technically subdivided into teethed, trundle, pin, crown, annular, and bevilled wheels, according to the shape, or the position, of the parts gearing, or working, into one another. Sometimes also a pinion may be made to revolve in, or upon, a straight piece of gearing, for the purpose of changing a continuous rotary to a horizontal motion, or *vice versâ*; or, again, the wheels may be susceptible of motion in alternate directions, or they may be intended only to revolve in one, in which case they either are made of such a form as themselves to act as ratchet wheels, or they are prevented from turning in the wrong direction by such a contrivance. In some cases also motion is given by the mere friction of the peripheries of the wheels upon one another, but evidently this can only be accomplished in very small machinery, or where the force to be transmitted is small. The principles upon which wheels of the various descriptions above-mentioned must be formed have been elaborately discussed in Camus, 'On the Teeth of Wheels,' by J. T. Hawkins, 1842; Moseley's 'Mechanical Principles of Engineering,' 1843; Warr's 'Dynamics,' &c., 1851; they will also be found in a condensed form under GEARING; MACHINE; WHEELS, TEETH OF.

Spindles, or shafts, are the axes upon which the various wheels are fixed, and by which the initial motion is distributed as may be desired. They may be of wood, or of metal; and if of the latter class of materials, either solid or hollow, square, hexagonal, or circular, as may be desired; the object to be aimed at being, in all cases, to make the shaft as light as possible consistently with the requisite degree of strength, and to reduce the dimension of the bearings to the minimum in order to diminish the friction. When shafts are made to revolve on a vertical axis, they turn on a pivot, or gudgeon; when horizontal shafts of great length are used, they turn in plummer blocks, or carriages. As it has been found practically that two loaded surfaces work upon one another with the greatest amount of friction when they are of the same material, it is usual to make the bushes or steps, in which the shafts or gudgeons work, of a different material to those parts of the machinery themselves; or in fact to make iron work on brass or gun metal, wood upon iron, &c.

Cranks and excentrics are the contrivances by means of which, in addition to wheels, the direction, or the nature, of the initial motion of a machine is transmitted to the work; or in other words, by means of which circular, and rectilineal, motion are reciprocally converted, or uniform velocity is changed into a variable one. The bell crank lever is the best illustration of the parts of machinery for transmitting a rectilineal motion in one direction to a shaft working in another direction; and according as the other end of that shaft may be attached to a crank working on a fixed axle around which it may revolve freely, or be attached to a part of the machine susceptible only of rectilineal motion, it will be able to convert the original rectilineal motion into another one of the same description, or into a curvilinear motion. The rack and pinion have been already cited as an illustration of the means of converting circular into rectilineal motion; and the common bow drill may be cited as an ordinarily adopted method of converting alternate rectilineal motion into alternate circular motion. Excentric wheels are, however, the most generally adopted means of converting curvilinear into rectilinear motion, and they may be either formed of circular wheels keyed upon shafts, whose axes do not pass through the centre of the former; or they may be what are called heart-shaped eccentrics; or they may communicate movement by pins working in slots. The cam is a contrivance frequently used for the purpose of converting continuous circular motion into an alternate vertical one, and this is effected in the case of tilt hammers by means of a series of eccentrics able to lift a lever, fixed at one end, in a gradual manner through a path corresponding to the highest point of the cam itself, after attaining which the lever is suddenly released, and of course falls. Varying rectilinear motion may be produced by modification in the shape of the cam in any way which may be required; and there are countless modifications of the traverses of machinery, whereby continued alternate motion is obtained from wheels or axles revolving in a circle. A reversing motion may be obtained by the use of a sliding bush working in a groove; and in the numerous tool-making machines of Mr. Whitworth, every description of change of motion from circular to horizontal may be observed. The crank is, it may be added, the most important element of machinery for the purpose of converting an alternate vertical, or horizontal, motion round a fixed centre, into a circular motion; and the parallel rods, so universally applied to connect the piston heads to the balance beams of steam engines, may be cited as amongst the most important combinations for the conversion of alternate vertical motion into a partial alternate circular motion round a fixed axis. CRANK; PARALLEL MOTION; STEAM ENGINE.

Drums and band-wheels are contrivances by means of which motion is communicated from one shaft, revolving on its axis, to another able also to revolve in a parallel direction, and either in the same or in opposite directions, through the interposition of straps of leather, gutta-percha, or elastic web. The advantage of this method of transmitting power is, that directly the resistance to be overcome exceeds the adhesion of the strap upon the band-wheel, the former slips, and is unable to produce motion; whereas when teethed wheels are used, if the resistance should be suddenly increased, there is a danger of producing a rupture, or at least a serious derangement, of the machinery. On the contrary, there is often a practical inconvenience in the use of straps, from the extension of the materials of which they are composed; and it is not therefore customary to resort to their use in heavy or important machinery. When it is desired to change the direction of motion of the shafts, the bands are crossed; and it is essential that, wherever it is possible so to do, the faces of the wheels should present slightly convex surfaces, in order to keep the bands steady. Band wheels, equally with teethed wheels, admit of an infinite variety of velocity combinations, of which the speed pulleys of the turning lathe may be cited as characteristic illustrations. Among practical men, the first motion band wheel is usually called the *drum*, and the second wheel is called the *pulley*; and the pulleys, where more than one are used, may either be fixed or loose, and made to work, by means of ratchets or of clutches, in any way that may be required.

Clutches, or the other varieties of loose coupling gearing, are used for the purpose of connecting or disconnecting parts of a machine when it may be desired to start its motion at will, or to arrest the same; whilst boxed couplings, or fixed connections, are used when the respective parts are intended to revolve continuously. The fast and loose pulley, the friction clutch, and the conical friction and reversing gear, have been introduced in order to obviate the danger which attends the abrupt connection of moving gear with portions of a machine in repose; but in spite of the inconvenience arising from this cause, and of the danger of stripping the teeth of cog-wheels when suddenly connected, through the inertia of the materials themselves, it is almost constantly the practice to allow the follower to fall upon and to fit into, the driver by means of a series of projections and recesses. Clutches or couplings should be placed as near to bearings or plummer blocks as possible, in order to secure the greatest possible amount of rigidity in the portions of the shafts connected.

After all, the most satisfactory way of explaining the construction of machinery is to refer to the best examples of the means of superseding the necessity for mere brute or manual labour; and a description, such as may be found in Warr's 'Dynamics,' of the recently invented turning-lathes, planing, punching, boring, drilling, screwing, and wheel-cutting machines, of the Nasmyth's hammer [HAMMER, POWER AND STEAM], and of the 'Times' printing machinery, will therefore teach the general reader far more of the power, the advantages, and the details of those various important inventions than any abstract remarks on the principles connected with them could do. The technical reader would also find it advisable to refer to special treatises on these subjects rather than to confine himself to general remarks; and he is therefore referred, in addition to the works already mentioned, to 'Buchanan on Mill-work,' new edition by G. Rennie; Coriolis, 'Mécanique des solides,' &c.; Hachette, 'Traité des Machines;' Borgnis, 'Traité des Machines;' and the various works which treat of the application of the power of the ordinary prime movers, such as steam, water, wind, horse, or man's power. [MOVING POWER.] Much information on these subjects is also to be obtained from the 'Mechanic's Magazine, the 'Transactions of the Society of Arts,' the 'Engineer,' and from Armangaud's 'Publication Industrielle des Machines,' &c., &c.

MACHINES, CALCULATING. Before computers had attained great proficiency in performing arithmetical operations by the pen, machines by which the results of such operations could be obtained by inspection were in almost constant use. The Roman abacus [ABACUS] continued to be employed in the south of Europe till the end of the 15th century, and in England to a later period. An account of the prismatic rods invented by Napier for the performance of arithmetical operations is given under NAPIER'S BONES; and the nature and use of the logarithmic scales, under SLIDING RULE.

The celebrated Pascal constructed, it is said, when only nineteen years of age, a machine for executing the ordinary operations of arithmetic. It was an assemblage of wheels and cylinders. On the convex surfaces of the latter were the numbers with which the operations were to be performed: these operations consisted chiefly in the addition and subtraction of sums of money having the denominations of livres, sous, and deniers, for which may be substituted pounds, shillings, and pence; and to those denominations the numbers were adapted. Extending round the convex surface of the first cylinder on the right hand of the machine, and one above the other, were the two series,

0, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1
11, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10;

the first of which served for the subtraction and the other for the addition of pence; the cylinder being turned in the same direction for both operations. Upon the surface of the next cylinder on the left were the two series,

0, 19, 18, 17, 16 1
19, 0, 1, 2, 3 . . . . . 18;

serving for the like operations on shillings: and on the left of this last were several cylinders, about each of which were the two series—

0, 9, 8, 7, 6, 5, 4, 3, 2, 1
9, 0, 1, 2, 3, 4, 5, 6, 7, 8;

and these were used for operations with pounds, or with any numbers in the decimal scale. Attached to the axles of the first cylinder was a wheel having on its circumference 12 teeth; on that of the second, one having 20 teeth; and on the axle of each of the other cylinders was a wheel having 10 teeth. Before an operation commenced, the zeros of the numbers in the first or second series above, on all the wheels, were brought by hand to the front of the machine. As an example of the method of using the machine, let it be required to add together the following sums of money :—

£8 9*s.* 8*d.*
4 15 6

By means of a pointer the wheel connected with the first cylinder on the right is to be turned till the eighth tooth, and under it the number 8 on that cylinder, are brought to the front; in like manner the number 9 on the second cylinder and 8 on the third are brought to the front; thus the series of numbers in the fronts of all the cylinders exhibits the first of the above sums of money. Then, by means of the pointer, the first wheel and cylinder on the right hand are to be turned till the sixth tooth (after the eighth) comes to the front, when the cylinder having, from its first position, performed on its axle one revolution and $\frac{2}{12}$ of another, the number 2, representing 12+2, or 1*s.* 2*d.*, appears in front. Now, by the construction of the wheel-work, one complete revolution of the first wheel and cylinder on the right hand causes the wheel and cylinder on its left to turn one-twentieth part of a revolution; by which means, in this example, the number 9 being already in front of the latter cylinder, the number 10 is now there: thus the one shilling obtained by the addition is, as it were, *carried.* The second wheel and cylinder being now turned by means of the pointer till the fifteenth tooth, after the tenth, is brought to the front, the number in front of the cylinder below is 5, representing 20+5, the cylinder having made $1+\frac{5}{20}$ revolutions from its first position; there is thus obtained 1*l.* 5*s.* One revolution of the second wheel and cylinder causes the next, towards the left, to make one-tenth of a revolution; and thus the 1*l.* is *carried*, so that the number in front of the third cylinder is now 9 instead of 8. This third wheel and cylinder are next turned by means of the pointer till the fourth tooth, after the ninth, is brought to the front, when there appears on the cylinder below it the number 3, representing 10+3; and the next cylinder on the left, in front of which was previously zero, has now 1, which may thus be said to have been *carried.* The subtractions are performed exactly in the same manner as the additions, by means of the numbers in the upper series on the cylinders.

Subsequently to the time of Pascal, Leibnitz invented a machine by which arithmetical computations could be made: but no account of it appears to have been published.

The most extraordinary calculating machine ever contrived is that of Mr. Babbage, which has had an eventful history. In 1822 Mr. Babbage read two papers before the Astronomical Society, descriptive of a machine which he had devised, for working mathematical questions of some complexity, and even printing its own results by means of types. An application was made to the government for pecuniary aid, in applying the machine to the construction of mathematical tables; and in 1823 the government sought the opinion of the Royal Society on the merits of the machine. A committee almost unexampled in scientific strength met to examine the question; it comprised the names of Davy, Herschel, Young, Wollaston, Pond, Kater, Brande, Baily, Brunel, Colby, and Davies Gilbert; and the highly favourable report sent in by this committee led the government to promise pecuniary aid, in a matter intended wholly for public benefit, and not for the inventor's emolument. Unfortunately, the arrangement was badly organised, and has given satisfaction to no one. The plan of the machine underwent changes, the drawings prepared were very elaborate, and artisans had to be specially educated to the work. By the year 1828, a sum of 3000*l.* had been advanced by the government; parliament complained, and the government complained, because no machine was yet forthcoming. A second committee of the Royal Society made a report, countenancing a further application of public money to this purpose. A sum of 3000*l.* more was advanced, and then 600*l.*, in 1829; besides a large expenditure out of the private purse of Mr. Babbage himself. In 1830 a third committee investigated the subject, at the request of the government; and the report of this committee led to a further advance of funds, not only for making the machine itself, but also for building a house to contain it. When 17,000*l.* had been spent, an irreconcileable dispute took place between the government and Mr. Babbage; no further money was given; and the operations were suspended. Mr. Babbage developed a new plan by which his machine would perform higher mathematical problems; his first he called a *difference engine;* the second would, if ever completed, be an *analytical engine;* but no funds being forthcoming, the operations were never resumed. In 1843 the government placed the difference engine, so far as it had been constructed, in the museum of King's College, London; and there it remains to the present time (1860), an unfinished memento of a splendid conception. The machine is barely a yard in height, by half a yard in width and a foot in depth; and it certainly appears surprising that no greater result than this has been presented for so enormous a sum of money.

So far as it is possible, we shall now describe the principle and action of Babbage's difference engine in a brief form: treating it as if the machine were finished and at work according to the inventor's plan.

In any series of numbers arranged in line or column, if the difference between the first and second, between the second and third, and so on, be taken, there will be formed a line or column of what are called first differences: if the difference between the first and second, between the second and third, and so on, of these last numbers be taken, there will be formed a line or column of what are called second differences. Proceeding in like manner to form third, fourth, &c. orders of differences, there will at length be found a series of differences which are either constant, or to a great extent are very nearly so. Thus, taking the series of numbers in the column N below, the several orders of differences will be as in the succeeding columns; the numbers in the sixth column being constant:

N	$\Delta^{\text{i.}}$	$\Delta^{\text{ii.}}$	$\Delta^{\text{iii.}}$	$\Delta^{\text{iv.}}$	$\Delta^{\text{v.}}$
243	781	1320	1230	600	120
1024	2101	2550	1830	720	
3125	4651	4830	2550		
7776	9031	6930			
16807	15961				
32768					
&c.	&c.	&c.	&c.	&c.	&c.

Now it is evident that, having any one of the numbers in the first column, and the numbers corresponding to it in the several columns of differences; all the succeeding numbers of the series may be found by mere additions. It may happen however that while the numbers in the original series increase, the numbers in some of the columns of difference may decrease; and then, in forming the terms of the series, subtractions might take place: in such a case, the arithmetical complements of the numbers to be subtracted being taken, the operations may still be performed by additions only.

Babbage's Difference Engine accomplishes these additions by the movements of a number of cylinders having on the convex surface of each the series of numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. The operations are thus distributed: by the first, the additions are made; and by the second, there is introduced the 1 which should be carried to the *ten's* place every time that the sum of two numbers is greater than 10. Let it be imagined that there are several vertical axles, on each of which are several cylinders one above another; and that these axles with their cylinders are capable of being turned by wheelwork, so that any one of the ten figures may be made to stand on the face of the machine, and immediately under a fixed index. Let it be further imagined that, when the moving power (the hand of the operator applied to a winch) has made one quarter of a revolution, the first, third, fifth, &c., axles may turn, causing the cylinders on them to make parts of a revolution or allowing them to remain at rest as the case may be, while all the cylinders on the second, fourth, &c., axles remain at rest. Again, when the moving power has made the second quarter of a revolution, let it be imagined that certain, only, of the cylinders on the first, third, fifth, &c. axles make one-tenth of a revolution, so that, whatever figure be under the index of each of these moving cylinders, the next figure, in increasing order, may be brought under that index; the cylinders on the second, fourth, &c., axles still remaining at rest. Let it next be imagined that, when the moving power describes the third quarter of a revolution, the cylinders on the second, fourth, &c., axles describe parts of a revolution or remain at rest, the cylinders on the other axles being unmoved: and lastly, when the moving power has described the fourth quarter of a revolution, let certain cylinders only on the second, fourth, &c., axles make one-tenth of a revolution, the other cylinders remaining at rest. Then it may be understood that by the first and third of these motions, numbers are added together: while, by the second and fourth, 1 is carried to each figure which ought to be increased in consequence of a sum of two figures being greater than 10.

As an example, let it be required to obtain the numbers of the series in the first column above, beginning with 3125. The figures composing the numbers are brought under the indices in front of the cylinders on the first vertical axis, towards the left hand; and the figures composing the several orders of differences in front of the cylinders on the other axis, towards the right, as in this second table.

N	$\Delta^{\text{i.}}$	$\Delta^{\text{ii.}}$	$\Delta^{\text{iii.}}$	$\Delta^{\text{iv.}}$	$\Delta^{\text{v.}}$
3	4	2	1	0	0
1	6	5	8	6	1
2	5	5	3	0	2
5	1	0	0	0	0

Then the moving power being turned one quarter of a revolution, each cylinder in the first, third, and fifth vertical columns will be turned through as many tenths of a revolution as are expressed by the number in front of the cylinder immediately on its right hand: thus, the cylinder having 3 in front (at the top of the first vertical column) will move through four-tenths of a revolution, and the number 7 will be brought under its index in front. The cylinder having 1 in front (in the first vertical column) will be turned through six-tenths of a revolution, which will bring 7 under its index in front;

and so on. The numbers in front of the whole machine will now stand thus:—

N	$\Delta^{\text{i.}}$	$\Delta^{\text{ii.}}$	$\Delta^{\text{iii.}}$	$\Delta^{\text{iv.}}$	$\Delta^{\text{v.}}$
7	4	3	1	0	0
7	6	3	8	7	1
7	5	8	3	2	2
6	1	0	0	0	0

By the addition (in the preceeding table) of 5 in the third column to 8 in the fourth, thore should be produced 13, whereas 3 only appears under the index of the cylinder (in the third column of the present table), therefore 1 must be *carried*. The operation of carrying is performed by the action of the moving power in the second quadrant of its revolution; and, in the present example, this does nothing more than turn the cylinder marked 3 (in the first line, third column) though one-tenth of a revolution, which brings 4 to the front of that cylinder. The reader may now imagine the 3 to be effaced, and the number 4 introduced in its place. Now the moving power turning through the third quarter of a revolution, the cylinders on the second and fourth axles are made to turn through as many tenths of a revolution as are expressed by the figures on the cylinders immediately on their right hand. Thus, the cylinder marked 4 in the column of the last table will turn through four-tenths, and this movement will bring to its front the number 8; the cylinder marked 6 will be turned through three-tenths of a revolution, which will bring to its front the figure 9; and so on. The numbers in front of the machine will now stand thus:—

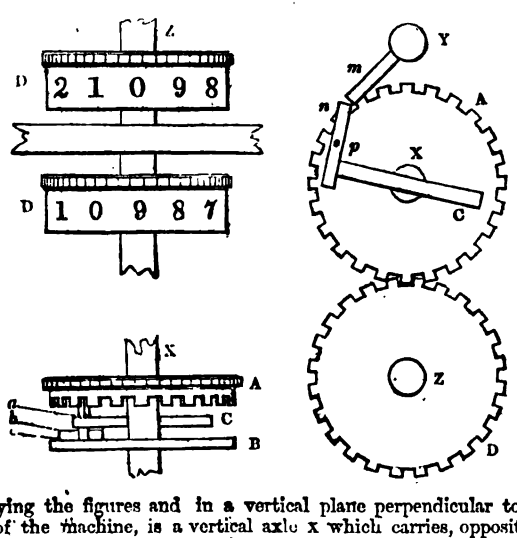
N	$\Delta^{\text{i.}}$	$\Delta^{\text{ii.}}$	$\Delta^{\text{iii.}}$	$\Delta^{\text{iv.}}$	$\Delta^{\text{v.}}$
7	8	4	1	0	0
7	9	3	5	7	1
7	3	8	5	2	2
6	1	0	0	0	0

The moving power turning through the fourth quadrant will perform the operations of carrying; and, in the present example, the cylinder marked 9 will turn one-tenth, which brings 0 (for 10) to its front; this causes another carrying, and the cylinder marked 8, in the same column, will turn one-tenth; which brings 9 to its front. The cylinder marked 1 in the fourth column will turn one-tenth on account of the carrying from the cylinder 5 below it, which brings 2 to its front; and the machine will stand thus:—

N	$\Delta^{\text{i.}}$	$\Delta^{\text{ii.}}$	$\Delta^{\text{iii.}}$	$\Delta^{\text{iv.}}$	$\Delta^{\text{v.}}$
7	9	4	2	0	0
7	0	3	5	7	1
7	8	8	5	2	2
6	1	0	0	0	0

The operation is now completed: the number succeeding 3125 in the series is 7776; and the like operations being performed with the instrument in the present state, the next number will be obtained in the first column. It has been supposed that the instrument has only six axles carrying cylinders; but it is evident that, if a number consisting of more than four places of figures were given, or were to be produced, a greater number of axles would be necessary.

In a limited space, we can do no more than give the following general notion of the mechanism by which these remarkable movements are produced. Immediately behind each column of the cylinders D carrying the figures and in a vertical plane perpendicular to the front of the machine, is a vertical axle X which carries, opposite to each cylinder, two horizontal wheels A and B, and between them a moveable bolt C, also in a horizontal position. These two wheels are capable of being connected with or disconnected from the axle, so that they may or may not turn with the latter. The upper wheel A is furnished with teeth, standing out horizontally from the rim, and these work in the like teeth formed about the cylinder D carrying the figures; so that the wheel A, when it turns with its axle, may be said to drive the cylinder. It is also furnished with teeth which are perpendicular to its lower surface, in the manner of an inverted crown wheel. The bolt C, which is under this wheel, and passes through the axle, is capable of being moved a short distance horizontally; it is provided, near its extremity, with a pin or tooth *a* standing perpendicularly above its upper surface, and with a pin *b* perpendicularly below its inferior surface. And the lower wheel B carries a wedge or inclined plane *c*. Behind the wheels on the axle X is another axle Y, which is also in a vertical position; this carries a projecting bar or finger *m* which revolves horizonally when the axle is made to turn by the action of the moving power. During its revolution it meets, at a proper place, one extremity of a lever *n* which is capable of turning on a pivot at *p*: that extremity being displaced, the extremity of the opposite arm presses against the end of the bolt C in the axis X and causes the upper pin *a* to enter between two teeth of the crown-wheel A. This wheel is thus fixed to its axle so as to be compelled to turn with the bolt; and the horizontal teeth of the wheel, consequently, cause the cylinder D carrying the figures to turn on its proper axis Z. Such is the nature of the mechanism that, while the moving power describes the first and third quadrants of its revolution, the cylinder D might make a complete revolution; but, in general, the cylinder is to make only as many tenths of a revolution as are expressed by the figure in front of the next cylinder on its right hand; and therefore the bolt is to be withdrawn from the crown-wheel when such part of a revolution has been performed. This is accomplished by the pin *b*, which, moving along the wedge or inclined plane *c*, draws the bolt back so that the pin *a* above is removed from between the teeth of the crown-wheel; the latter is thus disengaged from its axle and ceases to revolve: at the same time the cylinder D, with which it is connected by the horizontal teeth, ceases also to revolve. The cylinder remains then at rest till it is moved at a subsequent step in the process. If the cylinder is not to turn while the moving power describes the first and third quadrants, an apparatus provided for the purpose removes out of its place the lever which should press against the end of the bolt. For every vertical axis carrying cylinders in front of the machine, there is an axle carrying wheels and bolts, and an axle carrying the fingers which lock the bolts: and behind every cylinder is its proper apparatus, consisting of wheels, bolt, and finger.



The process of *carrying*, which takes place when the moving power is describing the second and fourth quadrants of its revolution, is accomplished thus:—A bar or finger revolves on the axle of the lowest cylinder D, for example, in the first vertical column on the left; and, at a proper time comes against the extremity of a claw which then engages itself between the teeth of a ratchet-wheel connected with the next cylinder above it: both the wheel and cylinder are thus made tc turn, but the length and position of the claw are such that the cylinder can only make one-tenth of a revolution, and thus bring to the front a figure greater by unity than that which was there before. When a cylinder has made the movement just indicated, a projecting pin, called a thumb, on the axle of the lower cylinder, touches a trigger which raises, out of a notch in the claw, a hook which retained the latter: a spiral spring then draws back the claw and allows it to fall between the next teeth of the ratchet-wheel without creating any movement in the cylinder; and the apparatus is thus prepared for the next carrying operation which is to take place.

It was proposed by the inventor to apply to the machine an apparatus by which the numbers obtained from the cylinders in the left-hand column might be immediately transferred, by the operation of *punching*, to plates of copper, in order that the results given by the machine might be printed without a possibility of error. To effect this, a curvilinear bar of metal was to act on an arm of a lever so as to raise it to ten different heights corresponding to the ten figures on the surface of a cylinder; and the opposite arm of the lever was to move an arch carrying ten punches having on them the characters 1, 2, 3, &c. in relief. The plate of copper being below, a bent lever was to press the punch upon the plate, and produce the impression of the figure. The different figures in front of the first column of cylinders would thus be successively transferred to the copper-plate; and the arch and plate being shifted, the set of figures brought in front of the cylinders in the same column, at the next operation with the machine, would be transferred in like manner.

If Mr. Babbage's plan had ever been fully carried out, the machine would perform the several operations of simple arithmetic on any numbers whatever. It would combine the quantities algebraically or arithmetically in an unlimited variety of relations. It would use algebraic signs according to their proper laws, and develope the consequences of those laws. It would arbitrarily substitute any formula for any other, effacing the first from the columns on which it is represented and making the second appear in its stead. It would effect processes of differentiation and integration on functions in which the operations take place by successive steps. The inventor further asserts that the engine would be particularly fitted for the operations of the combinatory analysis, for computing the numbers of Bernoulli, &c.

This machine embodies the principles of all the calculating machines yet proposed. A few words concerning other contrivances may, however, be desirable.

Staffel's arithmetical machine is about 18 inches in length, 9 in breadth, and 4 in height. It contains three rows of small cylinders, thirteen in the first row, and seven in each of the others; upon each cylinder are ten numerals, from 0 to 9. These cylinders act upon each other by means of small wheels, levers, sliders, and other delicate apparatus. The upper surface of the machine presents seven small holes, with moveable plates beneath them, marked by numerals, seven similar holes over the peripheries of seven little vertical wheels, and thirteen number-holes in a distinct row. Each set of seven holes has a traversing movement, but the longer row is immovable. Every one of the twenty-seven holes has ten numerals, from 0 to 9, belonging to it. In performing any sum, the conditions of the question are arranged on the two smaller rows; and then, by turning a handle, the result makes its appearance at the holes of the larger row. By different modes of adjusting the two smaller rows of holes, and of turning the handle, the machine performs addition, subtraction, multiplication, division, and evolution. It can multiply seven digits by seven, or millions by millions. A very beautiful part of the apparatus is a little bell, which rings whenever the operator attempts to perform an *impossible* operation, such as subtracting a larger number from a smaller, or dividing a smaller by a larger; the machine refuses to work, rings a bell, and stops.

Colmar's arithmometer is rather larger than Staffel's machine. It has as many slides, each working in a groove, as there are digits in the quantity which it is capable of calculating; and each groove is numbered with ten figures, from 0 to 9. There are as many round holes in a brass plate as there are possible places of figures in the result to be produced; and beneath each hole may appear any one of the ten numerals. The machine is adjusted to any particular problem or sum in addition, subtraction, multiplication, division, or evolution, by moving some among the many slides; these slides work upon certain wheels and levers underneath, which cause the proper figures for the result to make their appearance at the row of holes in the brass plate.

Wertheimer's machine, for the addition and subtraction of numbers and moneys, consists of a box having a metal plate divided into nine indexes, with semicircular notches, under which are placed a series of holes. Numerals are engraved round the indexes. The semicircular notches are furnished with teeth, with a pointer to insert between them, for the purpose of bringing the notch opposite to any particular figure.

Baranowski's Ready Reckoner is intended for the calculation of wages, prices, interest, and other sums of money. If it be to calculate the amount of wages at a given rate, the weekly rate, printed on paper, is brought to view in an opening in a brass plate, by means of a handle; a slide is withdrawn belonging to the particular number of days for which the calculation is made, another for any extra hours, and another for any odd quarters of an hour; and the printed figures revealed by the moving of these slides give the sum total of wages.

Schott's calculating machine can perform addition only. Lalanne's calculating-rule is a peculiar apparatus for solving the problems usually worked by the sliding-rule. Dr. Roget's sliding-scale of involution is like the apparatus just noticed, and bears more resemblance to the ordinary sliding scale than to a calculating machine. Maurel's calculating machine is something like Colmar's, founded mainly on the action of graduated slides. Roth's automaton calculator, and Slovinski's calculating machine, are two other examples mainly dependent on the same principle. Maurel's calculating machine works, like Colmar's, through the medium of graduated slides.

The most important calculating machine ever invented (next to Babbage's), and decidedly the most important ever actually finished, is Scheutz's. It presents another example of ingenuity ill rewarded. In 1834, after reading an account of Babbage's machine as at that time proposed, M. Scheutz, a technologist at Stockholm, conceived the idea of something to the same end on a different principle. Under Scheutz, George, and Edward, in the Biographical Division of this work, will be found a narrative of the circumstances connected with the invention and the difficulties which attended the construction of this machine, as well as some particulars respecting its principle, and the share taken by Mr. Babbage, the inventor of the first calculating machine, in directing the attention of the scientific men of this country to its value. The machine was exhibited in London in 1854, and in Paris in 1855; and in 1856 it was sold to the Dudley Observatory, at Albany, in the United States, at a price quite inadequate to the labour and thought bestowed upon it. Mr. Babbage deplored that the machine had not been secured for and by England; he greatly admired it, and attached high value to its power of computing mathematical tables. Not only can it do this, but it impresses each result on a piece of lead, from which a *cliché* cast in type-metal can be obtained, applicable to printing from. The machine, which is about the size of a square pianoforte, calculates to sixteen places of figures, and prints to eight. By taking out certain wheels and putting in others, the machine can be readily caused to produce and record its results in £ *s. d.*; in degrees, minutes, and seconds; in tons, cwts., and lbs.; or in any one among a large number of different modes. When once the machine is set with the conditions of the problem, a handle is turned, and the results appear at the rate of 25 figures per minute, not merely calculated and recorded, but actually stamped or impressed upon a plate of lead. Mathematically speaking, this is a *difference* engine, like Babbage's, and depending on the same general principles, though worked out by means of original details.

A full and minute description by the inventors of the machinery of this remarkable instrument is given in the specification of the English patent, dated October 17, 1854.

MACLAURIN'S THEOREM. [Taylor's Theorem.]

MADDER, COLOURING MATTERS OF. The root of the madder plant [Rubia *tinctorum*, in Nat. Hist. Div.] is so extensively used for the preparation of all shades of purple, red, brown, and even black dyes, that in importance to the calico-printer and others, it is second to no other dye-stuff, except perhaps indigo.

Madder grows in the south of Europe, many parts of the Levant, and is largely cultivated in Holland. It does not contain the colouring matter ready formed, nor does the substance from which the colour is derived reside indiscriminately in all parts of the plant. It is indeed only the ligneous or woody portion of the long fibrous roots of the rubia that are valuable, and hence the various operations that are performed upon them before being sent into commerce. These preparatory processes consist in, first, carefully drying the roots in a stove, then thrashing with a flail, winnowing and sifting away the dust or dried cellular matter, and finally, again drying, and, in nearly all cases, powdering the resulting fibres.

The ground madder thus prepared is called in France *garance*, but occasionally it is sent out in the entire state, especially from Turkey and the Levant, and is then called *lizari* or *alizari* (from ριζάρι, the modern Greek name for madder).

Madder thus prepared has a reddish appearance, and contains three distinct colouring principles, namely: 1. *Alizarin*; 2. *Purpurin*; and 3. *Rubiacin*. Of these, alizarin is the one of greatest importance. Madder also contains, 4. *Chlorogenin*—a green, pulverulent species of extractive matter; 5. *Erythrozym*, a ferment; and 6. *Rubian*, a body of deep yellow colour, not, however, a colouring principle in the practical sense of the term, but which, by the action of ferments, acids, or alkalies, yields up large quantities of alizarin.

1. *Alizarin* ($C_{28}H_{10}O_8 + 6HO$) *Lizaric acid.* This substance, though chiefly resulting from the decomposition of rubian during the dyeing operations, has nevertheless been shown by Schunk to exist ready formed in dried madder, and has probably been produced from the rubian originally in the plant by the action of a ferment in the drying operations.

Alizarin was first discovered by Robiquet and Colin. It is identical with Runge's *Madder red*. It may be extracted directly from the root, but is best obtained from *garancin*, a substance prepared by acting upon powdered madder, with strong hot sulphuric acid, by which the earthy matter and a large quantity of valueless tissue is rendered soluble, and is removed by well washing the residue with water. The dried, insoluble portion constitutes the garancin; it is very largely used in print works, and it is from this that alizarin is most conveniently prepared. The garancin is boiled for some time with a quantity of water, and the colouring matters precipitated from the resulting liquor by sulphuric acid. The precipitate well washed with cold water, dried, and submitted to sublimation, yields beautiful orange coloured needles of alizarin. An impure alizarin was described by Robiquet and Colin, under the name of *colorin*.

Alizarin is tasteless and inodorous, neutral to test paper, almost insoluble in cold water, more so in hot water, and freely taken up by alcohol or ether. The alkalies dissolve it, forming a beautiful purple solution, but acids reprecipitate it unchanged. It forms a splendid red lake with alumina, and purple ones with lime, baryta, and oxide of iron. Alizarin is converted into phthalic acid (alizaric acid) by ebullition with dilute nitric acid, and since chloroxynaphthalic acid, a body prepared from naphthalin, also yields phthalic acid under the same circumstances, it has been thought, that chloroxynaphthalic acid is simply alizarin with an atom of hydrogen replaced by one of chlorine. Schunk, however, does not think this to be the case, nor has Strecker himself, who was the first to throw out the hint, been able to replace the chlorine in chloroxynaphthalic acid by hydrogen and thus convert it into alizarin. Were this accomplished, naphthalin would no longer be a waste product as it now is, but become of great value and importance.

Alizarin plays the principal, and probably the only part, in the production of madder colours. Schunk has, in fact, after a long course of experiments, been led to the conclusion, that the final result of dyeing with madder and its preparations is simply the combination of alizarin with the various mordants employed, and that consequently if an economical method of preparing alizarin on a large scale could be discovered, a great gain would result to the arts.

2. *Purpurin* was the name given by Robiquet and Colin to the colouring matter that remained dissolved in the alum liquor after the preparation of alizarin. Dr. Debus has called it *oxylizaric acid*. It dissolves in alkalies with a red colour, quite distinct from the purple of an alkaline solution of alizarin, and moreover the resulting solution decomposes when exposed to the air, which is not the case with a similar solution of alizarin. Professor Stokes, who has examined the optical properties of purpurin, also thinks it quite distinct from alizarin; nevertheless, these two bodies are shown, by other re-actions,

to be closely allied substances. Further research will probably remove all doubt concerning them.

3. *Rubiacin* ($C_{32}H_{11}O_{10}$). This body is one of several yellow colouring matters contained in madder. It was first noticed by Runge, who called it *Madder-orange*. Schunk has obtained it in acicular and lamellar crystals. It gives red compounds with bases, but does not contribute to the production of fast colours during the process of madder dyeing; Schunk thinks that it even acts injuriously. Persalts of iron convert it into *rubiacic acid* ($C_{32}H_9O_{17}$), a lemon yellow, non-crystalline powder. *Rubiacate of potash* crystallises from water in long, silky, brick-red needles.

Rubiacin is soluble in strong sulphuric acid, and hence is found in the acid liquor mentioned when treating of the preparation of alizarin.

4. *Chlorogenin*.—Kuhlman, by treating garancin with boiling alcohol, evaporating to dryness, dissolving in water, precipitating with acetate of lead and baryta water, and treating the precipitate with dilute sulphuric acid, isolated a body that he called *xanthin*. Schunk, however, shows that this body is a mixture of rubian and an extractive matter to which he has given the name *chlorogenin*, the *rubichloric acid* of Rochleder. Its aqueous solution becomes brown when exposed to the air, and hence the uniform dirty reddish-brown tint which a piece of calico exhibits after having been dyed with madder. In the manufacture of garancin, the chlorogenin is mostly decomposed and removed. The effect of adding lime to a dye-bath is partly, according to Schunk, to take away the chlorogenin, rubiacin, and other valueless and injurious bodies from their aluminous combination.

5. *Erythrozym* is the name given by Schunk to an azotised body existing in madder. It acts as a ferment, and bears the same relation to rubian that emulsin does to amygdalin. It is the ferment peculiar to madder, or rather to rubian, the latter body not yielding alizarin when brought in contact with other ferments. It contains very little more than 4 per cent. of nitrogen. It may be obtained from madder by digesting the latter in water at 100° Fahr., and precipitating the aqueous extract with alcohol.

6. *Rubian* ($C_{56}H_{34}O_{30}$). Madder is extracted with boiling water, the extract agitated with animal charcoal, and the latter digested in alcohol. A solution is thus obtained which leaves on evaporation a nearly pure substance, to which Schunk has given the name of *rubian*. It is an amorphous, gum-like mass, of deep yellow colour, intensely bitter taste, and soluble in water and alcohol. By the action of various agents it is broken up into grape sugar and alizarin, together with 7. *Rubiretin*, and 8. *Verantin*; the latter substance being accompanied by 9. *Rubiafin*, 10. *Rubiagin*, 11. *Rubianin*, and 12. *Rubiadin*, according to the reagent employed, as seen in the following table :—

By Ferments.	By Acids.	By Alkalies.
Alizarin. Rubiretin. Verantin. Rubiafin. Rubiagin ?	Alizarin. Rubiretin. Verantin. Rubianin.	Alizarin. Rubiretin. Verantin. Rubiadin.

7. *Rubiretin* ($C_{28}H_{12}O_8$), and 8. *Verantin* ($C_{28}H_{10}O_{10}$), are amorphous, resinous, and of brown colour. Along with alizarin they form the part insoluble in cold water when rubian is acted upon by either of the agents named. Rubiretin is easily soluble in alcohol: verantin less soluble in that liquid.

9. *Rubiafin* ($C_{32}H_{12}O_9$) accompanies the last-named bodies when the splitting up is effected by erythrozym. When treated with perchloride of iron it passes, like rubiacin, into rubiacic acid. It crystallises in yellow shining needles.

10. *Rubiagin* accompanies rubiafin. It seems to be a distinct substance, but Dr. Schunk has not yet obtained it in a state of purity.

11. *Rubianin* ($C_{44}H_{24}O_{20}$) accompanies alizarin, rubiretin, and verantin, when rubian is decomposed by acids. It is tolerably soluble in boiling water, and crystallises in lemon-yellow silky needles.

12. *Rubiadin* ($C_{32}H_{12}O_9$). This body is associated with the other three when rubian is acted upon by alkalies. It crystallises in beautiful golden-yellow scales, insoluble in water, soluble in alcohol, and is completely volatilised by heat.

13. *Chlororubian* ($C_{44}H_{27}ClO_{24}$). When exposed to the action of chlorine, rubian is converted into a crystallisable substance, called by Schunk *Chlororubian*. It is insoluble in water, but soluble in alcohol. It is formed from rubian by the elimination of one atom of sugar, and the replacement of an atom of hydrogen by one of chlorine. By the continued action of chlorine it is converted into *Perchlororubian* ($C_{44}H_9Cl_9O_{15}$). By the action of acids upon chlororubian a second atom of sugar is set free, and *Chlororubiadin* ($C_{32}H_{12}ClO_9$) is formed.

14. *Rubianic acid* ($C_{52}H_{29}O_{27}$). (*Ruberythric acid*, Rochleder.) This acid results from the action of alkalies and oxygen upon rubian; a vessel to which the air can have access being therefore used in its preparation. It gives definite crystalline compounds with the alkalies, is tolerably soluble in boiling water, and crystallises in lemon-yellow silky needles. By decomposition it yields one atom of alizarin, and two of grape sugar.

Madder-dyeing. The colouring matters of madder have but little affinity for cotton fibre, but a great affinity for mordants; hence, when a pattern has been printed on cotton with a mordant [Calico-Printing, col. 516], and the whole passed through the madder bath, it is not difficult to remove the colour from the un-mordanted portions, and thus secure a good white ground.

Madder colours are very stable, resisting the action of air and light in a remarkable degree. Turkey-red cloth is a well-known illustration of this fact.

From a consideration of the properties of the various substances contained in madder, Dr. Schunk is enabled to explain several curious phenomena observed in madder-dyeing which were not previously known. For instance, it is well known that the sudden heating of a madder-bath produces prejudicial effects. This no doubt arises from a stop being put to the action of the ferment (erythrozym), and the consequent non-production of the whole of the alizarin from the rubian. Hence, too, the advantage of mixing several sorts of madder together, some containing excess of rubian, some excess of ferment. Again, it is well known that up to a certain time madder improves by keeping; this, no doubt, is owing to the thus increased action of the ferment, an action that evidently commences so soon as the madder-roots are gathered from the soil.

MADHOUSE. [Lunatic Asylums.]

MADNESS. [Insanity; Lunacy.]

MADRIGAL, in music, an unaccompanied vocal composition, sometimes in three parts, but commonly in more; and as the true madrigal is written in what is termed the learned style—abounding in points of the fugal or imitation kind—it is, almost necessarily, as much the produce of study as of genius. Morley—himself a renowned writer of madrigals—says that in this sort of composition "no point is to be long stayed upon, but once or twice driven through all the parts, and sometimes reverted [inverted], and so to the close, then taking another. And that kind of handling points is most esteemed when two parts go one way, and two another way, and most commonly in tenths or thirds. Likewise the more variety of points be showed, the more is the madrigal esteemed: and withal you must bring in fine bindings (sincopations) and strange closes, according as your ditty shall move you. Also in compositions of six parts (or five) you must have an especial care of causing your parts to give place one to another, which you cannot do without resting; nor can you cause them to rest till they have expressed that part of the dittying which they have begun." ('Treatise,' 1597.)

The madrigal is to be traced to a very early period in the history of vocal music in parts: to the Flemings we are indebted for its birth, about the middle of the 16th century, and the Italians took it up shortly after, with what success the names of Palestrina, Marenzio, Conversi, Ferretti, &c., will bear witness. Nor were the English deficient in emulation or slow in manifesting it; Morley's first book of madrigals was published in 1594, Weelkes's in 1597, Wilbye's in 1598, Bennet's in 1599, and only a few years later, John Ward's and Orlando Gibbons's appeared. Dowland's and Ford's lovely compositions, the former published in 1597, and the later in 1607, have the title of madrigal bestowed on them, but they are more properly *part-songs*, or what would now be called *glees*. It is not too much to say, that the English madrigalists have no superiors, and that for the preservation of this high order of composition, the art has long been, and still continues to be, indebted to the Madrigal Society, a club, consisting chiefly of amateurs, founded in London in 1741, and which, by zeal and perseverance, has succeeded in diffusing throughout the British Isles a taste for a species of music as delightful as it is scientific, and exactly suited to the choral societies already existing, or springing up, in all our great manufacturing and commercial towns.

Every attempt to fix, with any precision, the derivation of this word, has been baffled. Menage thinks that *Mandra*, 'a sheep-fold,' is its source, for he supposes it to have been, in its origin, a pastoral song. Bishop Huet considers it a corruption of *Martegaux*, a name given to the inhabitants of a district of Provence, who, according to a learned French writer, excelled in the species of poetical composition called the *Madrigale*. Dr. Burney agrees with Doni, who derives it from *Alla Madre*, the first words of certain short hymns addressed to the Virgin, and afterwards to the mother of Love, *Madre galante*. And Sir John Hawkins remarks, that there is a town in Spain named Madrigal. But all these conjectures—for they amount to no more—are merely plausible, and we only offer them in the absence of a more satisfactory etymology.

The English glee [Glee] is probably a graft of the madrigal. The finest madrigals belong to the 16th century; but the term *glee* does not seem to have been used before the middle of the 17th century, at which time a glee was defined as "a song of three or more parts upon a gay or merry subject, in which all the voices begin and end together, singing the same words." It will be seen that the structure of the madrigal is much more complicated than this, although some of our glees might be appropriately termed madrigals.

MAGAZINE. Magazines are of two descriptions, permanent or temporary. Permanent magazines are strong buildings constructed generally of brick or stone within a fortified place, or in the neighbourhood of a military or naval station, in order to contain in security the gunpowder or other warlike stores which may be necessary for the defence of the place, or for the use of the troops who are to perform military duty in the province or district. Temporary magazines are such as are constructed during a siege for the supply of the batteries, &c., or such as are hastily constructed in a fortress for expense magazines.

On account of the liability of gunpowder to become deteriorated by humidity and by variations in the state of the air, the buildings in which it is contained are constructed with every precaution necessary to ensure dryness, and, as nearly as possible, a uniformity of temperature within them. They are generally in places remote from other buildings; they are furnished with metallic conductors, in order to avert danger from lightning; and, for security against the attempts of ill-disposed persons, they are surrounded by a wall and ditch. When in situations where they may become the objects of hostile measures, they are made shell-proof.

A magazine within the walls of a fortress is usually formed on an esplanade; and, if small, it may be in the interior of some bastion remote from the front against which an attack of the enemy is likely to be directed. But it would be preferable that such buildings should be in some work beyond the main rampart of the place, that an accident may be attended with as little detriment as possible.

The powder required for the immediate service of the works on the front attacked is taken from the general magazine, and placed in what are called *expense magazines;* that is, in temporary bomb-proof buildings, or in casemates formed in the rampart along that front, from whence it is conveyed to the batteries. These casemates or *souterreins* should be as well ventilated as possible, by having doors and windows in the interior side of the rampart, and loop-holes or small perforations on the side next to the main ditch. They sometimes constitute the only bomb proofs belonging to a fortress; and then they become of the utmost importance, serving as well for the abode of the troops, when not on duty, as for the preservation of the powder and stores. [BOMB-PROOF; CASEMATE.] In such situations however, as magazines, they are subject to some disadvantages from which isolated buildings are free; for besides the humidity, which the means they possess for ventilation are not sufficient entirely to remove, the blowing up of any one by an accident would evidently destroy the rampart, and expose the place to the risk of an immediate assault. And when the vault springs from the back of the wall which constitutes the exterior revêtment of the rampart on any face of the work, its lateral pressure would facilitate the formation of a breach by overturning the wall as soon as the latter became weakened by the fire from the enemy's battering artillery.

The dimensions of magazines are necessarily dependent on the quantity of powder which they may be required to contain. Vauban, in his 'Traité sur la Défense des Places,' speaking of such as are made in the ramparts of fortresses, recommends them to be from 8 to 12 feet wide, with semicircular-headed vaults; and he proposes that the barrels of powder should be placed in them in two rows, with a passage from 3 to 4 feet wide along the middle. The great magazines which have been constructed in this country consist of several parallel vaults, separated from each other by brick partition-walls, in which are doorways for affording lateral communication. Each vault is about 90 feet long and 19 feet wide internally, and it has a door at each extremity. The side walls are from 8 to 10 feet thick, and are strengthened by buttresses built at intervals against them. The concave or interior surface of each vault, in a vertical and transverse section, is nearly of a parabolical figure, above the springing courses; and the exterior surface has the form of two inclined planes meeting in a longitudinal ridge-line above the middle of the vault. The thickness of the brickwork forming the vaulted roof is therefore various; at the crown it is 7 or 8 feet, and on the hances about 3 feet, this being considered sufficient to resist the shock of falling shells. The vault, on the exterior of the inclined planes, is covered with flat tiles, slates, or, still better, asphalte; and the gutter between every two roofs with sheet-lead or copper. The height interiorly, from the level of the floor to the crown of the arch, is 19 feet; and the lines at which the vaulting springs from the side walls are at half that distance above the floor. The narrow vertical perforations which are made through the side and end walls, for the purpose of giving air to the interior, are cut so as to leave a solid block or traverse of the brickwork in the middle of the thickness of the wall; the line of the perforation branching laterally from its general direction, and passing along the two sides of the traverse. By this construction, while air is admitted, no object capable of doing mischief can be thrown in from the exterior of the building. The flooring-planks are, of course, laid on joists raised considerably above the ground. One vault, of the dimensions above given, would contain 2500 barrels, or 225,000 lbs. of powder.

When the roof of a magazine is covered with earth to the height of several feet, for the purpose of securing it effectually against the effect of falling shells, the rain-water absorbed by the earth may at length penetrate through the brickwork to the interior of the building. In order to prevent this effect it has been proposed that the roof should be covered with common hollow tiles, having their concave surfaces upwards, and that, over these, boards should be laid to carry the earth. The absorbed water would thus drain off in the channels formed by the tiles, and be conveyed away by the gutters between the roofs.

Temporary magazines, such as are formed to supply the batteries in a siege, are necessarily made of wood. They are of three descriptions, the rectangular, the lean-to, and the triangular.

The lean-to magazine, which was the one principally employed by the British army in the Peninsula for field powder magazines, is formed by laying stout timbers, generally termed splinter-proof timber, at an angle of 45°, sloping towards the fortress, against an earthen parapet (revêted interiorly), so as to enclose a space of which the section is nearly a right-angled triangle. The splinter-proof timbers are then covered with earth; from its great inclination this face is well able to resist the effects of vertical fire or shells falling on it, while the powder is protected in front by the parapet from the effects of shells fired horizontally. This form of magazine, however, is very ill adapted for stowage.

The triangular field powder magazine, the section of which is an isosceles right-angled triangle, is also bad for stowage, and takes long to construct. It may, however, be placed in a traverse or parapet. The size as adopted at Chatham was 15 feet 6 inches in length of body of magazine, 6 feet 6 inches wide at bottom, and 6 feet 6 inches high in the clear; or, with the length increased to 18 feet to allow of a low passage, 2 feet 6 inches wide and 4 feet 6 inches high, leading perpendicularly from one end of the magazine to the rear. The interior form of the magazine is preserved by five triangular frames of carpentry, with sheet planks and fascines in front. The body of the magazine may be sunk 4 feet.

The rectangular field powder magazine, which is the one now generally adopted in the British service, consists of a rectangular excavation 12 feet 3 inches long by 6 feet 3 inches wide, with a passage at right angles to its length at the end of one side, running to the rear. The sides are formed by rectangular frames 4 feet 9 inches high and 4 feet 4 inches wide from out to out; behind these, to support the earth, sheeting planks 1¼ inches thick are placed. Over the top, supported at each end by the frames, are splinter-proof timbers about 6 inches in width by 9 inches in depth, the whole being covered with earth to the thickness of about 5 feet. The sheeting is not carried along the whole of both sides, but stops short of one frame, which is the entrance from the passage, the passage being formed something like the gallery of a mine; the frames of the passage are only 2 feet 2 inches wide. There are then four body-frames, two on each side, opposite to one another, and four passage-frames, two in the body of the magazine, opposite to one another, and two more for the continuation of the passage to the rear. The tops of the frames are on the level of the ground, the magazine being sunk below that level; and a small ditch, which supplies earth for cover, surrounds the magazine, leaving a parapet of about 4 feet in breadth all round it. This is the best description of field magazine, especially for stowage.

MAGELLANIC CLOUDS. [NEBULÆ.]

MAGI, the name of the priests among the Medes and Persians, whose religious doctrines and ceremonies are explained under ZOROASTER, in BIOG. DIV. The Magi formed one of the six tribes into which the Medes were originally divided (Herodot. i. 101); but on the downfall of the Median empire they continued to retain at the court of their conquerors a great degree of power and authority. It would appear however that they did not witness with indifference the sovereignty pass from the Medes to the Persians; and it was probably owing to the intrigues of the whole order that a conspiracy was formed to deprive Cambyses of the throne by representing one of their order as Smerdis, the son of Cyrus, who had been previously put to death by his brother. Herodotus, who has given the history of this conspiracy at length, evidently regarded it as a plot on the part of the Magi to restore the sovereignty to the Medes, since he represents Cambyses on his death-bed as conjuring the Persians to prevent the Medes from obtaining the supremacy again (Herodot., iii. 65); and the Persians themselves must have looked upon it in the same light, since after the discovery of the conspiracy, and the murder of the pretended Smerdis by Darius Hystaspes and his companions, a general massacre of the Magi ensued; the memory of which event was annually preserved by a festival, called the "Slaughter of the Magi" (Μαγοφόνια), in which none of the Magi were allowed to appear in public. (Herodot., iii. 79; Ctesias, 'Pers.,' c. 15.) This event does not appear to have much impaired their influence and authority, for they are represented by Herodotus, in his description of the Persian religion, as the only recognised ministers of the national religion (i. 132).

The learning of the Magi was connected with astrology and enchantment, in which they were so celebrated that their name was applied to all orders of magicians and enchanters. Thus the Septuagint translates the Chaldee אָשַׁף "enchanter," by the word *Magus*, *μάγος*. (Dan., i. 20; ii. 2, 27; compare Acts, xiii. 6, 8.) The word was also applied to designate any men celebrated for wisdom; whence the wise men of the East who came to see Christ are called simply Magi. (Matt., ii. 1, 7, 16.)

It would appear from a passage in Jeremiah (xxxix. 3), that the Babylonian priests were also called Magi, if at least the interpretation of *Rab-Mag* (רַב־מָג), "chief of the Magi," be correct. (Gesenius, 'Hebrew Lexicon,' under מָג)

The etymology of this word is doubtful. In Persian the name for priest is *mugh;* and it is not improbable, as Gesenius has conjectured, that the word may be connected with the root meaning *great*, which we have in the Greek *μέγ-ας*, the Latin *mag-is* and *mag-nus*, the Persian *mih*, and the Sanskrit *mah-at*. It is a curious fact that the Hindu grammarians derive *mah-at* from a verb *mah*, signifying "to worship." (Wilson's *Sanskrit Dictionary*, under *mah-at*.)

MAGIC LANTERN is a species of lucernal microscope, its object being to obtain an enlarged representation of figures, on a screen in a darkened room, by means of the pencils of light issuing from a lamp or candle and passing through a convex lens.

The instrument consists of a lantern, generally of tin, and of a cubical form, in the interior of which is the light; and at a perforation in one of the sides is applied a tube projecting horizontally from it. Immediately before the aperture, and within the tube, is a glass lens, often nearly a hemisphere and three or four inches in diameter, serving to condense the light which proceeds from the lamp both directly and by reflexion from a concave mirror attached to the side of the lantern which is directly opposite the aperture: this tube carries within it another, which is also provided with a convex lens, and is capable of a small movement for the purpose of adjustment.

A groove in front of the lantern and parallel to that front receives a rectangular frame containing the glass plates on which are painted, with transparent colours, the objects of which an enlarged view is to be obtained. Instead of a single convex lens, the sliding tube is sometimes provided with two such lenses; these are placed at a short distance from one another, and have between them a perforated plate of tin, or diaphragm, crossing the interior of the tube, for the purpose of cutting off the more divergent rays which would render the figures indistinct. The lens, or pair of lenses, is of such a focal length that the rays in each of the pencils which proceed from the object may unite on the screen in what is called the *conjugate focus*, and thus produce the enlarged representation of the figure.

Several figures are usually drawn on the same plate of glass, and the plate is capable of being moved by hand in the groove so that the different figures may be brought successively before the spectator: for the purpose of heightening the effect, motions can be given to the figures by means of a simple wheel-work.

The magic lantern is said to have been invented by Kircher, in the 17th century; it is described by him in his 'Ars Magna Lucis et Umbræ.' Cellini, however, who died in 1570, describes some magical effects, such as spectres in the midst of ascending smoke, &c., which are easily produced by the magic lantern, so that Kircher, who was not born until the year 1601, was but a re-inventor, or perhaps only a describer of an instrument, the possessors of which would be likely to keep it secret as far as possible. The celebrated Euler proposed to substitute for the lens of the lantern a concave mirror, perforated in the middle like that of a Gregorian telescope: this was to be placed in the interior of the lantern with its polished surface towards the light and its convexity towards the object. The light was to be so disposed that none of it should pass directly through the aperture in front of the lantern so as to fall on the screen; and that which was reflected from the concave mirror, after falling upon one with a plane surface, was from thence to be reflected in a contrary direction upon the object. The rays in the pencils proceeding from the object were to pass through a lens in the tube, as in the former construction; and, by converging with greater accuracy to points on the screen, they would have produced a more correct image than that which results from refracted light alone.

The magic lantern must have been at best an imperfect affair until the invention of the Argand lamp, by Ami Argand in 1789, by which a clean, clear, bright flame was for the first time produced in lamps. It was not, however, until 1802, that any decided improvement was made, and then M. Philipsthal exhibited at the Lyceum in London the form of instrument known as the *Phantasmagoria*. The lantern itself was similar to but larger than that which served for more general purposes; and the sliding tube which carried the farthest lens had a greater range of motion. The objects to be exhibited were painted upon a glass plate, with this remarkable difference from former attempts, namely, that all the parts not occupied by the figure, were covered with an opaque varnish, so that no light could pass except through the figure, which was thus rendered more brilliant. The machine was placed upon a stage capable of being moved on wheels in a direction perpendicular to the screen on which the objects were represented. The screen was a curtain made of fine muslin or gauze, and covered with varnish so as to be quite transparent: it was stretched in a vertical position across the theatre or apartment; and this being made quite dark, the spectators occupied the space in front of the screen, while the apparatus was disposed on the opposite side.

In any magic lantern when the tube carrying the lens which is farthest from the lamp is drawn out as much as possible, the magnitude of the image represented on a screen is the smallest; the image increases in magnitude in proportion as the tubes are diminished in length, or as the lens is brought nearer to the body of the lantern. It increases also in proportion as the whole machine is made to recede from the screen; and the variations of the length of the tubes must, by the exhibitor, be combined with the different distances of the lantern from the screen, in order that by the just convergence of the rays in each pencil, on the screen, the proper degree of distinctness of vision may be obtained under all the variations in the magnitude of the image. The consequence of this is the very serious defect that when the image is smallest, and apparently farthest off, it is brightest, and when large, and apparently near, the light is comparatively faint from being spread over a larger surface. This is partially remedied by intercepting a portion of the light, when the image is small and bright, by means of a gauze screen: an ingenious *artificial iris* has also been contrived for the purpose.

Care is taken that during the exhibition all light shall be excluded both before and behind the screen, except that which, in proceeding from the lantern, produces the image to be observed; and the screen being itself invisible, the spectators can scarcely divest themselves of the idea that they are looking into a dark cavern, in which the objects, at first dimly visible as specks in its deepest recesses, appear to be gradually advancing towards them, increasing in magnitude as they seem to approach: after the objects have been some time apparently in the immediate presence of the company, perhaps surrounded by a blaze of light, they seem as gradually to retire, and at length they vanish, leaving the place in profound darkness.

Several of these particulars are derived from a 'Treatise on the Magic Lantern,' written in 1854 by Mr. Tomlinson, and published by a maker of the instrument for the benefit of his customers. This treatise lets us into the secret of many of the effects which always excite the admiration, if not the wonder, of the spectators. The following, for example, is the introduction to a description of *dissolving views*:—

"Dissolving views are produced by means of two magic lanterns of the same dimensions and optical power. They are placed on the same table or horizontal plane, with their lens-tubes inclined towards each other in such a way as to produce a single disc of light upon the opposite wall or screen, instead of two discs, which would be formed if the lens-tubes were parallel. Now it is evident that if by the conjoint action of these two lanterns a disc of light be formed on the screen, the dark shutter of either lantern may be let down, without destroying such disc, but only depriving it of half its light. Suppose, further, that each lantern contained a slider, one representing the exterior of a building, and the other representing the interior, if both lanterns were acting on the screen at the same time, the super-position of images would produce a confusion which the eye could not unravel; but if the dark shutter were let down, so as to intercept the light of one lantern, the other would act with full effect. While the spectators are enjoying one view, the shutter of the other lantern is raised, and that of the first is gradually let down; and it is during this process of moving the shutters that the dissolving effect takes place, because a portion of the light from both lanterns falls upon the screen at the same time; but the moment one shutter is quite down and the other fully raised the dissolving effect ceases. There is one effect which usually excites a great deal of surprise among the spectators—namely, the view of the interior of a large building, deserted and solitary, and while the spectator is gazing, the same building becomes filled with people; this is produced by painting the same building on two sliders of precisely the same dimensions, and with all the same details in both cases, only in one case empty and in the other full of people; or as it is not necessary to repeat any part of the painting, one slider may have the building only, and the other the people on a ground of the deepest shade used in the former slide. While the lantern containing the slider representing the empty building is acting on the screen, the shutter of the other lantern is slowly raised, and that of the first as slowly lowered. Thus without any necessary dissolving effect, since the two sliders represent the same object, the empty building appears gradually to fill with people. In the same way a leafless tree covered with snow, may quickly put on the verdure of summer."

In the following passage the means of producing some of the effects before referred to are described:—

"Many beautiful effects are produced by allowing both lanterns to act together; one lantern being first employed to produce an effect, and the other being used to heighten it, or to produce some new feature. Thus, for example, a rainbow may be made to appear in the sky of a landscape, as represented by one lantern. For this purpose the landscape without the rainbow is shown by one lantern, and a slider containing only a rainbow, or a sky and a rainbow, being placed in the second lantern, the shade is removed from it, and the landscape is enlivened by this beautiful addition. By means of a second slider, lightning may also be represented, but in such case the effects of the flash are due to two glasses, both blackened, and containing the same flash of lightning, one of which is fixed and the other moveable. The latter is moved rapidly so as to allow the flash to be seen for an instant and then shaded from view. The dancing of the *aurora borealis* is produced in a similar way. The whirling of smoke issuing from a volcano is produced by a painting set in a circular brass frame, and capable of revolving round and round by means of a little cog-wheel fitting into the teeth of a circular rack. On turning a handle which projects from the side of the slider, the cog-wheel is made to revolve, and this gives motion to the ring of teeth to which the painting is attached. In this way the smoke appears to whirl out of the crater of the volcano, and to be dissipated by the wind. An effect which produces great surprise is that of falling snow. This is managed by a piece of black silk perforated with holes formed into a roll, mounted in a mahogany frame, and used as a slider, as the paintings are. By means of a small projecting handle at the side the silk can be wound upon another roller and in its passage will present the effect of falling snow. The landscape exhibited by the other lantern is a winter scene: but before the snow slider is called into action, darkness is made to come over the landscape by means of a piece of black crape held over the aperture. As the lantern inverts the images, and the sliders are put in with what may be called the wrong side up, so by winding the silk from the bottom roller on to the top one, the ascending holes appear to form a descending shower on the screen."

MAGIC SQUARE. This term is applied to a set of numbers arranged in a square in such a manner that the vertical, horizontal, and diagonal columns shall give the same sums. Such arrangements were known very early to the Hindus, Egyptians, and Chinese, among whom, as also among the Europeans of the middle ages, a belief existed that such squares had astrological and divinatory qualities. Emanuel Moschopulus,[*] of Constantinople, wrote on them in Greek in the middle of the 15th century. Others who have written on the subject are Leibnitz, Frenicle, Bachet, La Hire, Saurin, &c. (See Montucla's 'History,' vol. i., p. 346; 'Encyclopédie Méth.,' article 'Quarrés magiques;' Hutton's 'Dictionary;' and the 'Mathematical Recreations' of the same author.)

Though the question of magic squares be in itself of no use, yet it belongs to a class of problems which call into action a beneficial species of investigation. Without laying down any rules for their construction, we shall content ourselves with destroying their magic quality, and showing that the non-existence of such squares would be much more surprising than their existence.

Take any set of numbers in arithmetical progression, and such that their number shall be a square number, say the first sixteen numbers—

1	2	3	4	5	6	7	8
16	15	14	13	12	11	10	9

any of these in the first half, with its corresponding number in the second half, makes up 17. Write the numbers in the following manner:—

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Take four of these in such a manner as to take one out of each row, and one out of each column, and it will be found, and may easily be proved, that the sum of numbers in every such set must consist of two pairs of corresponding numbers, so that their sum must be twice 17, or 34. The different ways in which this can be done are in number 4 × 3 × 2 × 1, or 24, as follows.—

1	6	11	16	5	2	11	16	9	2	7	16	13	2	7	12
1	6	15	12	5	2	15	12	9	2	15	8	13	2	11	8
1	10	7	16	5	10	3	16	9	6	3	16	13	6	3	12
1	10	8	15	5	10	15	4	9	6	15	4	13	6	11	4
1	14	7	12	5	14	3	12	9	14	7	4	13	10	7	4
1	14	11	8	5	14	11	4	9	14	3	8	13	10	3	8

Out of these subdivisions a set may be taken from each, so that no number shall be repeated, in 24 different ways, as in the following sample, which shows the four ways that begin with 1 6 11 16.—

1	6	11	6	1	6	11	16	1	6	11	16	1	6	11	16
5	2	15	12	5	2	15	12	5	10	15	4	5	14	3	12
9	14	7	4	9	14	3	8	9	14	3	8	9	2	15	8
13	10	3	8	13	10	7	4	13	2	7	12	13	10	7	4

Now in each of these 24 squares, every horizontal row can be written in 24 orders [COMBINATIONS], and in putting the different orders together, each square admits of 24 × 24 × 24 × 24, or 331,776 arrangements, without altering the horizontal rows, but only the order of the figures in each row. But the order of the horizontal rows can be varied 24 ways in each square, and there are 24 squares; so that we have 331,776 × 24 × 24, or 191,102,976 squares, no one of which repeats any number more than once, and in every one of which the sum of any horizontal row is 34, made by two pairs of numbers which give 17 each. But the number of ways of forming 34 out of four of the first sixteen numbers is not yet exhausted: for, taking any one set, say

1 16 11 6

in which 1 and 6 correspond to 16 and 11, we may write 2 and 5, or 3 and 4, for 1 and 6, so that we have not included in the preceding list

2	16	11	5
3	16	11	4

with all their variations of order; and similar ones for all the rest of the list. It would be almost impossible to doubt that in many of this enormous number of squares, the vertical columns will sometimes be cases of these new sets: and it would be something short of magic if some should not also have diagonal columns which fulfil the same condition. In fact, Frenicle has shown 880 methods of making these squares magical, a few of which are as follows ('Divers Ouvrages, &c. Paris, 1693):—

1	16	11	6	4	11	14	5	13	4	5	12	16	3	10	5
13	4	7	10	6	13	12	3	16	6	11	1	8	2	13	11
8	9	14	3	9	2	7	16	3	9	8	14	9	15	4	6
12	5	2	15	15	8	1	10	2	15	10	7	1	14	7	12

8	12	5	9	8	10	3	13	8	12	5	9	10	11	5	8
11	1	16	6	15	1	12	6	10	1	16	7	15	2	16	1
13	7	10	4	9	7	14	4	13	6	11	4	6	7	9	12
2	14	3	15	2	16	5	11	3	15	2	14	3	14	4	13

In Frenicle's list of 880, only those squares are included which are essentially different: thus the following four, which may be made by turning the last square into different positions, count only as one.

10	11	5	8	8	1	12	13	13	4	14	3	3	6	15	10
15	2	16	1	5	16	9	4	12	9	7	6	14	7	2	11
6	7	9	12	11	2	7	14	1	16	2	15	4	9	16	5
3	14	4	13	10	15	6	3	8	5	11	10	13	12	1	8

The methods which have been given for the formation of magic squares are divided into different rules, according as the number in each side is odd, evenly even, or oddly even. A general method which shall apply to all cases is yet wanting. For a full account of these rules see Hutton's 'Mathematical Recreations.'

MAGISTERY. The term used by alchemists to denote precipitation of metallic solutions by water; thus, the basic nitrate of bismuth, precipitated on diluting the neutral nitrate, was termed magistery of bismuth.

MAGISTERY OF BISMUTH. [BISMUTH, *Mononitrate of.*]

MAGISTRAL. Roasted copper pyrites employed in the extraction of mercury from its ores by amalgamation.

MAGISTRATE, a word derived from the Latin *magistratus*, which contains the same element as *magnus* and *magister*, and signifies both a person and an office. A Roman magistratus is defined to be one who presides in a court and declares the law, that is, a judge. The kings of Rome were probably the sole magistratus originally, and on their expulsion the two consuls were the magistratus. In course of time other offices, as those of Prætor and Ædile, were created; and those who filled these offices were elected in the forms prescribed by the constitution, and they had jurisdictio. [JURISDICTION.] The original notion of a magistratus, then, is one who is elected to an office, and has jurisdiction.

In England the term magistrate is usually applied to justices of the peace in the country, and to those called police or stipendiary magistrates, such as there are in London. It has also been applied in other ways; for instance, people have sometimes said that the sovereign is the chief magistrate in the state. But these applications of the term do not agree with its proper sense.

MAGNA CHARTA. The terms of the compact between the feudal chief and his dependants underwent frequent changes in the middle ages, the consequence for the most part of resistance made by the tenants, and struggles to regain liberties which had been originally surrendered or taken from them by the force and power of the chief. When a material alteration was made in the terms of the compact, a record was made of it in writing. These records are called charters, in the restricted use of a term which is popularly applied to almost every species of early diplomas. The tenants of the various honours, or great tenancies in capite, are seldom without one or more charters which have been granted to them by their lords, by which exemptions or privileges are given, base services are commuted for payments in money, and the mode is settled in which justice shall be administered among them. And even in some of the inferior manors there are charters of a similar kind by which certain liberties are guaranteed by the lord to his tenants. These charters run in the form of letters, "*Omnibus,*" &c., from the person granting; they set forth the thing granted, and end with the names of persons who were present when the lord's seal was affixed, often ten, twelve, or more, with the date of place and time of the grant.

Such a charter is that called the Magna Charta granted by King John, but acting in his twofold character of the lord of a body of feudatories, and the sovereign of the realm. This charter is often regarded as the constitutional basis of English liberties, but in many of its provisions it seems to have been only a declaration of rights which had been enjoyed in England before the Conquest, and which are said to have been granted by King Henry I. on his accession. However, if it did not properly found the liberties which the English nation enjoys, or if it were not the original of those privileges and franchises which the barons (or the chief tenants of the crown, for the names are here equivalent), ecclesiastical persons, citizens, burgesses, and merchants, enjoy, it recalled into existence, it defined, it settled them, it formed in its written state a document to which appeal might be made, under whose protection any person who had any interest in it might find shelter, and which served, as if it were a portion of the common law of the land, to guide the judges to the decisions they pronounced in all questions between the king and any portion of the people.

Beside the great charter there was granted at the same time a charter relating to the forests only. There were very extensive tracts of land in England which were actually forests, uncultivated, and reserved for the pleasure of the king; and there were purlieus to these forests, all of which were subject to a peculiar system of law, many parts of which were felt to be oppressive, and from some of which this charter exempted the people.

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[*] Some think this work was written by Emanuel Moschopulus the elder, a Cretan, who lived at the end of the 13th century.

The independence and rights of the church were also secured by the great charter.

Magna Charta has been printed in a great variety of forms; there are fac-similes of a copy of it which was made at the time, and still exists in the British Museum, and of another preserved at Lincoln, and translations of it into the English language. It is thus so easily accessible, that it will not be expected that we shall give a copy of it, or even a complete abstract of its multifarious provisions, some of which are completely obsolete, and the terms obscure.

Such a concession from the king was not gained without a violent struggle; in fact he was compelled to yield it by an armed force, consisting of a very large portion of the baronage, which he was far too feeble to resist with effect. The names of the chiefs are preserved by the chroniclers of the time, and in the charter itself; and whenever recited, they call up to this day a mingled feeling of respect and gratitude, the respect and gratitude which men pay to those who have obtained for them the extension of political privileges, though it may appear that those privileges were nothing more than rights of which they had been deprived, and to which therefore they may be said to have been justly entitled. They appear the patriots of a rude age, and the mists of distance and antiquity obscure to us the selfishness and the other evils (if such existed) which were manifested in the contest. The first name is that of Robert Fitz-Walter, who belonged to the great family of Clare. The title given to him as head of the host was Marshal of the Army of God and of the Holy Church. Next to him come Eustace de Vesci, Richard de Percy, Robert de Roos, Peter de Brus, Nicholas de Stutevile, Saier de Quenci, earl of Winchester, the earls of Clare, Essex, and Norfolk, William de Mowbray, Robert de Vere, Fulk Fitz Warine, William de Montacute, William de Beauchamp, and many others of families long after famous in English history, the progenitors of the ancient baronial houses of England.

The charter was signed, or rather sealed, not in any house, but in the open field, at a place called Runnymede, between Windsor and Staines; but it was not merely by an accidental meeting of two armies at that place that this act was done there, for it appears by Matthew of Westminster that Runnymede was a place where treaties concerning the peace of the kingdom had been often made. All was done with great solemnity. The memorable day was June 5, 1215.

What was unwillingly granted, it could scarcely be expected would be religiously observed. John himself would gladly have infringed or broken it, as would his son King Henry III., but the barons were watchful of their own privileges, those of the church, the cities, the boroughs, and of the people at large; and King Henry was led to make one or more solemn ratifications of the charter. To keep the rights thus guaranteed fully in the eyes of the people a copy was sent to every cathedral church, and read publicly twice a year.

See the work of Sir William Blackstone, entitled 'The Great Charter and Charter of the Forest (on Public Wrongs), with other authentic Instruments; to which is prefixed an Introductory Discourse concerning the History of the Charters,' Oxford, 1759, 4to. He wrote also an express treatise on this charter. An exact fac-simile has been engraved and published of the charter, from a copy preserved in the archives of the cathedral church of Lincoln, with other of the greater charters. In the first volume of 'The Statutes of the Realm,' published by the Board of Commissioners on the Public Records, these charters are all printed, with English translations of them.

MAGNESIA. [Magnesium.]

MAGNESIA, MEDICAL PROPERTIES OF. Oxide of magnesium, termed also, from the mode of procuring it, calcined magnesia, or magnesia usta, is an alkaline earth possessing the usual qualities of alkalies in their habitudes with acids, and likewise the peculiar property of exciting generally purgative action of the intestines. This last-mentioned power gives it a distinctive character among alkaline remedies, as it can be employed not merely to counteract acidity, but also to remove the exciting cause when that consists in the presence of crude or undigested acid-yielding materials in the stomach. Its action as a purgative seems mainly to depend upon its meeting with acids in the stomach, and so forming soluble salts. When these are not present the magnesia remains undissolved, and if used repeatedly may accumulate in the intestines, and, becoming agglutinated by the mucous secretions, give rise to much uneasiness. Hence some other aperient should from time to time be given. [Antacids.] When however acidity exists, either along with constipation or diarrhœa, more particularly in children, from the milk disagreeing, or from a diet unsuited to their delicate organs of digestion being forced upon them, magnesia is a very proper medicine, especially as it appears to possess a specific power of diminishing gastrointestinal irritation. (Hufeland, quoted in Pereira's 'Materia Medica.') It is generally expedient to add rhubarb to it, and combine it with some carminative. In such a state of combination it is peculiarly useful in what is termed diarrhœa crapulosa, arising from too great a mixture or too large a quantity of food.

Where it is determined to use magnesia, and sufficient acid does not exist in the stomach to ensure the formation of a soluble salt, a little lemon-juice may be added to it. The subcarbonate of magnesia has nearly the same action as the calcined magnesia, but when it meets with acids in the stomach effervescence takes place, accompanied with a disengagement of carbonic acid gas, which in some cases is inconvenient, in other instances extremely beneficial. In some almost uncontrollable irritations of the stomach, where food and medicines are alike rejected, subcarbonate of magnesia will be retained, and, by allaying the irritability, allow other remedies to be subsequently employed. Both the subcarbonate and the calcined magnesia are much used to correct heartburn, and to check the lithic acid diathesis; but their employment requires much judgment and attention [Antacids; Antalkalies], as persisting too long in the employment of this or any alkaline preparation brings on a phosphatic condition.

Sulphate of Magnesia, or Epsom salts, in the ordinary form, as met with in the shops, are small acicular crystals. This renders them liable to be confounded with those of oxalic acid; to avoid which the sulphate may be dissolved, and by recrystallisation they are obtained in large four-sided prisms, or four-sided pyramids. The taste of sulphate of magnesia is bitter and very unpleasant; but this is very much lessened by large dilution in water, which at the same time increases the purgative action of the salt, or by adding magnesia, or by giving it in compound infusion of roses and adding a few drops of dilute sulphuric acid, which augments the refrigerating property of the medicine. The addition of a little common salt to a solution of sulphate of magnesia increases its cathartic powers.

No saline medicine is so extensively employed as the sulphate of magnesia as a purgative; it is more rarely used as a diuretic or diaphoretic. Its action as a purgative is in general mild and certain, causing a considerable evacuation of the serous secretions of the intestines, and so producing a cooling or lowering effect. At the commencement of most inflammatory complaints and of fevers its employment is most beneficial. Its utility is often much increased by adding to the solution a very minute portion of tartarised antimony, so as to form the emetico-cathartic solution, which is found very serviceable in the fevers of India, and in those of the summer and autumn of European countries.

Small doses of sulphate of magnesia in bitter infusions are valuable in the treatment of dyspepsia accompanied with constipation. Many of the saline mineral waters resorted to for the cure of indigestion are chiefly indebted to the sulphate of magnesia for their purgative properties.

Sulphate of magnesia is a convenient antidote in cases of poisoning by the salts of lead or baryta. The saccharate of magnesia is an eligible form of exhibiting magnesia to children.

Magnesian limestone is sometimes employed for building, and is a very durable stone: it is however one of the most deleterious stones for masons to hew, as the gritty particles very speedily occasion disorders of the lungs, followed by early death. The mouth and nostrils of the workman should therefore always be defended by wearing a gauze mask.

MAGNESIUM (Mg). This metal was first obtained by Sir Humphry Davy, but its oxide or *magnesia*, and carbonate, or *magnesia alba*, have been known since the commencement of the last century. Its compounds are frequently met with in the inorganic kingdom, but are not so abundant as those of lime.

Magnesium may be obtained from its chloride by heating with potassium or sodium, or by subjecting the same salt to a voltaic current obtained by means of a few cells of a Bunsen's battery. Deville and Caron give the following details for the reduction of the metal. Six parts of chloride of magnesium are well mixed with one part of a fused and powdered mixture of chloride of potassium and sodium, one part of pure fluoride of calcium, and one of sodium in small pieces. The mixture is transferred to a red-hot earthen crucible, fitted with a lid. After some time the reaction takes place, and when the hissing noise has ceased, the lid of the crucible is removed, and the mixture stirred with an iron rod until the whole appears uniformly mixed, and the upper portion of the liquid mass is clear. The crucible is then removed from the fire, and when the saline mass is nearly solidifying, it is to be stirred with an iron rod so as to collect the suspended particles of metal. When cold, the mass is broken up, and the globules of crude magnesium picked out.

The metal thus obtained may be purified by placing it in a carbon tray, and heating it to whiteness in a carbon tube, a current of hydrogen being at the same time passed over it; it is subsequently re-melted with chloride of magnesium, chloride of sodium, and fluoride of calcium.

If, in the above process, the current of hydrogen is rapid, the vapour of the magnesium is to a certain extent carried out of the tube, and on being ignited, burns with an exceedingly beautiful flame.

Magnesium is a metal of silvery white colour, and semi-crystalline or fibrous fracture. It fuses and votalilises at about the same temperature as zinc, to which metal it in many other points bears a very close analogy. It is malleable and ductile, may be easily polished, readily filed, and yields well to the chisel. Its specific gravity is 1·75. It does not tarnish in dry air, and in a damp atmosphere oxidises but slowly. This metal takes fire at about the temperature at which glass melts, and burns with a steady and most brilliant flame. Could a cheaper process be discovered for the manufacture of magnesium, thin wires of it spun into a wick might no doubt be advantageously used in many instances as a source of light. Magnesium crystallises in octohedra. It acts but very slightly upon cold water, and is not rapidly oxidised by hot water. It ignites when brought into contact with hydrochloric acid; sulphuric acid dissolves it slowly with evolution of hydrogen.

The equivalent of magnesium is 12.

Magnesium and *oxygen* form only the following oxide :—

Magnesia, calcined magnesia, or *oxide of magnesium* (MgO). Prepared by heating the carbonate to full red heat. Its density depends upon that of the carbonate employed; if a light variety has been used, then *light* calcined magnesia results, but if a heavy carbonate, then *heavy* calcined magnesia is obtained.

Magnesia is a white powder, very voluminous, inodorous, and tasteless. In the oxyhydrogen blowpipe flame it fuses to a hard opaque enamel. Moistened with water it acts upon test paper like an alkali. Magnesia is a powerful base, forming salts with the acids that are usually very stable.

Hydrate of magnesia (MgO, HO) is precipitated in a semi-gelatinous state when an alkali is added to an aqueous solution of a salt of magnesia. It also occurs native. [Magnesia, in Nat. Hist. Div.]

Iodide of magnesium (Mg I). Magnesia dissolves in aqueous hydriodic acid, forming a difficultly crystallisable salt. On exposure to heat, it gives off hydriodic acid, and magnesia is left.

Bromide of magnesium (MgBr) may be prepared in the same manner as the iodide, than which it is far more stable. This salt is also found in sea water, and in many salt springs.

Magnesium and *chlorine* form

Chloride of magnesium (Mg Cl). Magnesia dissolves in hydrochloric acid, forming chloride of magnesium, but this solution cannot be evaporated to dryness without undergoing decomposition, unless chloride of ammonium is present, when a stable double salt is formed. This salt loses its chloride of ammonium when heated to redness, and the fused chloride of magnesium may then be poured out on to a slab. Thus obtained, it forms a white crystalline semi-translucent solid, very deliquescent, very soluble in water, and tolerably so in alcohol. It quickly decomposes in contact with air, and must therefore be kept in well closed bottles.

Carbonate of magnesia (MgO, CO_2), occurs native in acicular crystals. [Magnesite, in Nat. Hist. Div.] It is also deposited in small prismatic crystals, containing three equivalents of water of crystallisation, when a solution of magnesia in carbonic acid is allowed to evaporate spontaneously.

Magnesia alba, the common magnesia of the shops, is a mixture of *carbonate* and *hydrate* of magnesia ($MgO, CO_2 + MgO, HO$) in very variable proportions, the carbonate however nearly always preponderating. It is made by mixing together solutions of sulphate of magnesia and carbonate of soda, the latter being in excess, collecting, well washing, and drying the precipitate. It is an exceedingly light powder, inodorous, and almost tasteless. Its density varies according to the strength of the solutions employed, being greatest when the two salts are mixed together, without the addition of water, fused in their water of crystallisation, evaporated to dryness, and the sulphate of soda subsequently washed out. The *heavy carbonate* thus produced is, however, liable to be semi-crystalline, or *gritty*.

Bicarbonate of magnesia ($MgO, 2\,CO_2$). This salt exists only in solution, and is made by passing carbonic acid through water in which carbonate of magnesia is suspended.

Sulphate of magnesia ($MgO, SO_3 + 7\,HO$). This salt was originally obtained in 1697, from the Epsom waters, by Dr. Grew, and hence its common name of *Epsom salts*. It occurs in sea-water, and in many mineral waters, and is largely prepared from *bittern*, or the mother liquor from which common salt has crystallised after sea-water has been evaporated; the first crystallisation is called *single epsoms*, and when recrystallised is denominated *doubles*. The principal source, however, of sulphate of magnesia is *dolomite*, or *magnesian limestone*, a double carbonate of lime and magnesia. [Magnesian limestone, in Nat. Hist. Div.] Chippings of this stone may be readily procured, as it is in very common use for building purposes, and on acting upon it with sulphuric acid, the carbonic acid is evolved, sulphates of lime and magnesia are formed, and the latter is separated from the former by simple solution in water, sulphate of magnesia being very soluble, while sulphate of lime is almost insoluble. On evaporating the solution, the sulphate of magnesia crystallises out. When prepared in this way, however, it frequently contains sulphate of iron, but this may, if necessary, be got rid of by calcining the salt. The sulphate of iron is then decomposed, peroxide of iron remaining while the sulphate of magnesia is unaltered, and may be dissolved away from the oxide of iron by water.

On evaporating and slowly cooling a solution of sulphate of magnesia, large four-sided rhombic prisms are obtained, but by rapid cooling and frequent agitation small acicular crystals are deposited, forming the *Epsom salts* as met with in pharmacy.

Sulphate of magnesia is colourless, transparent, and inodorous, but has an extremely bitter taste. Heated, it fuses, parts with its water of crystallisation, and finally becomes anhydrous. The crystals slowly effloresce in very dry air. Five parts dissolve in four of water at 66° Fahr., and in still less of boiling water. Sulphate of magnesia is also exceedingly soluble in hydrochloric acid, but insoluble in alcohol.

Nitrate of magnesia ($MgO, NO_5 + 6\,HO$). Formed by dissolving carbonate of magnesia in nitric acid, and concentrating by evaporation. It then crystallises out in rhombic prisms and needles, very deliquescent, very soluble in water, and soluble also in nine times their weight of alcohol. They are almost insoluble in absolute alcohol.

Phosphate of magnesia and ammonia ($2\,MgO, NH_4O, PO_5 + 12\,HO$). Precipitated in a granular form, when phosphate of soda is added to a solution of magnesia in chloride of ammonium, containing also ammonia. By heat it is converted into bibasic phosphate, or pyrophosphate, containing 36·67 per cent. of magnesia.

Silicates of magnesia. Many of these occur native. See Steatite, Meerschaum, and Hornblende, in Nat. Hist. Div.]

Citrate of magnesia ($3\,MgO, \overline{Ci}, HO$). Prepared by saturating citric acid with carbonate of magnesia. It is less bitter than most of the magnesian salts.

Effervescent citrate of magnesia, or *granular citrate*, as it is sometimes called, is nothing more than a mixture of bicarbonate of soda and tartaric acid, with a small but variable quantity of sulphate of magnesia: sometimes it contains a little citric acid. It is made by well mixing the ingredients, slightly moistening till the mass begins to swell from disengagement of carbonic acid, and then rapidly drying over a water-bath with constant stirring.

Double salts of magnesia, especially with alkaline salts, are very numerous.

Tests for magnesia. Magnesia is characterised by its not being precipitated from solution by hydrosulphate or carbonate of ammonia in the presence of chloride of ammonium, and by a granular precipitate with phosphate of soda and with arseniate of ammonia, especially if free ammonia is present.

Estimation of magnesia. This is generally effected in the state of bibasic phosphate ($2\,MgO, PO_5$), in the manner already mentioned under phosphate of magnesia.

MAGNET. The *natural magnet*, *loadstone*, or *lodestone*, is known in mineralogy as *magnetic iron ore*. It consists of one equivalent of protoxide and one equivalent of sesquioxide of iron (FeO, Fe_2O_3), and possesses the remarkable property of attracting iron and some other metals. It is said to have been found abundantly near Magnesia in Lydia, from which circumstance its name may have been derived from the Greek *μάγνης*. The attracting power of the magnet was known at a very early period, as references are made to it by Aristotle, and more particularly by Pliny, who states that ignorant people called it *ferrum vivum*, or quick-iron. The same author appears to have been acquainted with the power of the magnet to communicate properties similar to its own to other bodies.

The universal law, that re-action is co-existent with action, implies, that iron must re-act on the magnet, and we find in fact, that if a piece of iron be fixed, and a small magnet be suspended by an untwisted line near it, the magnet will then be moved towards the iron; thus all the iron in the mass of the globe acts upon a magnet. It is also known that electrical currents influence magnetic bodies [Electro-Magnetism] while heat has an influence on magnetic intensity. Hence it follows as a mechanical consequence, that if a magnetic needle or cylinder be suspended by its centre of gravity, so as to be free to move in any direction round that point, it will not take an arbitrary position like unmagnetised bodies, but must take a specific direction, namely, that which represents the resultant of all the magnetic forces to which it is subject. Its position in a given place can be defined by two angles, the one called the *variation* or *declination*, the other the *inclination* or *dip*. The first is the angle formed by the vertical plane in which the needle lies with the plane of the meridian; the second is the inclination of the line of the needle to the plane of the horizon. The latter is avoided in the compass-needle by sustaining it horizontally on a point which is necessarily different from its centre of gravity, and the variation is then the angle made by the direction of the needle with that of an exact and horizontal north-and-south line. This property of the needle is called its *polarity*, and is a consequence of its other properties above noticed; the fact, however, escaped the notice of the Greeks and Romans of antiquity, but the Chinese appear to have been acquainted with it from a very remote date. The Chinese name it, according to its most valuable property, *tchu-chy*, or the "directing stone." In Tonkinin it is called the "stone which shows the south." In Swedish it is *segel-sten*, or the "seeing stone;" in Icelandic, *leiderstein*, or the "leading stone," after the Saxon *lædan*, "to lead," whence the English *lodestone*. In a similar way is derived the term *lode-star*, or "guiding star," as applied to the pole-star, and the term *lode*, the "leading vein," in a mine. Polarity is the most useful of the known properties of the magnet, being of the most essential importance to the mariner, when the magnet is constructed in the form of the compass-needle. [Compass, History of the.]

Dr. Gilbert, who was physician in ordinary to Queen Elizabeth, states that P. Venetus brought a compass from China in 1260. Gilbert bestowed much attention on the subject of magnetism, and to some extent inculcated the doctrine of gravitation, by comparing the earth to a great magnet. His theory on this subject is given in a work entitled 'Tractatus sive Physiologia nova de Magnete' (1600), and the term "poles of a magnet" arose from that theory, which is remarkably consonant with the notions of the present day: for the north pole of the magnet he denominated the south pole, in connection with his theory, while Poisson, in his elegant 'Memoirs on Magnetism,' calls the magnetic fluid at that extremity of the magnet the *austral fluid*, because, as like electricities repel [Electricity], so, on his hypothesis of the magnetic fluids, that occupying the north end of a magnetised needle is repelled by the boreal fluid of terrestrial magnetism.

The application of the compass to the purposes of navigation must speedily have led to the discovery of its variation, and in the 'Life of Columbus,' written by his son, it is distinctly assigned to that celebrated man; and though its amount in 1492 must have been small in France, Spain, &c., yet it was doubtless a very observable quantity in many of the regions visited by Columbus. Some have carried back the date of this discovery to the year 1269, but on very doubtful grounds. When its amount came to be observed with some accuracy, we find it at Paris, in 1541, 7½° E.; in 1550, 8½° E.; in 1580, 11½° E.; in 1630, 4½° E.; and at Rome, in 1670, 2° W. The following table shows the variation at London in different years:—

	East declin.		Zero.	West declin.				
Years . .	1580,	1622.	1660.	1692,	1730,	1765,	1818,	1850.
Declination .	11° 15′	6°	0°	6°	13°	20°	24° 41′	22° 30′

[Declination of the Magnetic Needle.]

It is not improbable that Columbus was acquainted also with the diurnal variation, but nothing very accurate on this subject was known before the numerous and valuable observations made by Canton, in 1750. He showed that the needle vibrates, during the day and the night, through an arc as great as 13½′ in the midsummer, the minimum 7′ occurring in the winter season; he ascribed the diurnal variation to the action of solar heat affecting the intensity of the magnetism of the earth. The principles of thermo-electric currents were at that period unknown; but Hooke, in 1684, showed that iron and steel rods could be magnetised by rapidly heating and cooling them in the magnetic meridian. Graham, instrument-maker, of London, was the first who distinctly announced the diurnal variation, in 1772; the maximum declination being then 14° 35′ west. The variation of the variation was first observed by Gunter. [Gunter, in Biog. Div.]

The *dip* was first observed by Robert Norman in 1576. His mode of adjusting the compass-needle led him to this discovery; for he accurately balanced the needle on its pivot previous to magnetising it. After it became a magnet it would no longer balance on the same point, without attaching a small weight at the south extremity. When freely suspended by the centre of gravity, the north extremity became depressed, the dip then being about 71° 50′. The dip undergoes diurnal variations, as well as the declination; but observations on the former are far the most difficult. The dip also changes by elevating the needle to considerable heights, on which subject Biot has made some very delicate experiments. A very simple law relative to the amount of the dip at different parts of the earth's surface was remarked by Professor Krafft, of St. Petersburg, in 1809; namely, if we measure the latitude from the magnetic equator, the tangent of the dip is double the tangent of such latitude. Mr. Barlow has illustrated this law by experiments on magnetised iron *balls* acting on small needles at the surfaces; and Biot has deduced the same law from theory.

The following is the inclination for London in the years stated:—

1576	71° 50′
1676	73° 30′
1723	74° 42′
1790	71° 53′
1800	70° 35′
1821	70° 30′
1830	69° 38′
1860	68° 30′

The law of the magnetic forces was a long time undiscovered: Newton supposed it to follow the inverse cube of the distance, or some higher power; for in his experiments, the variation of intensity and the effect of the mutual influences of the magnetic fluids in the bodies themselves being overlooked, an erroneous result was necessarily consequent. However, Mitchell, by a careful revision of the experiments of Dr. Brooke Taylor and of Hauksbee; Coulomb, by his elegant apparatus, the torsion balance; Biot, by the method of observing the times of the oscillations of the small needles acted on; and Hansteen of Christiania, by a series of refined experiments and calculations, have demonstrated the true law of magnetic action,—namely, directly as the intensity, and inversely as the square of the distance. But for the discussion of the whole question, we refer to Harris's 'Rudimentary Magnetism,' part iii. [See also Terrestrial Magnetism.]

One essential property by which a magnet differs from soft iron under the magnetic influence, is this: if we separate a magnetic bar into any number of minute parts, each such part will be endowed with polarity, similar to the whole: the position of those poles, or foci of greatest attraction, is permanent in a magnet of a given form; but in soft iron it will change when the distance of the iron from the influencing magnet is altered.

Halley was sent out, under William and Mary, with the command of two ships, to make magnetic observations in different latitudes, both in the Atlantic and Pacific (in 1698-9), and was the first who constructed a magnetic chart, which possessed at the time great merit for accuracy: the most valued at the present day are those by Hansteen, constructed from observations subsequent to Halley, by various scientific travellers and nautical men, such as Humboldt, Ross, Parry, Scoresby, &c. [Terrestrial Magnetism.]

During a thunder-storm the poles of a magnet are frequently inverted, the explanation of which belongs to Electro-Magnetism; and the appearance of the aurora borealis is often attended with vibrations of the compass-needle, to the extent of several degrees. The actual mode in which the aurora is produced being still only matter of conjecture, it is impossible to decide whether the aurora is itself the cause of this magnetic phenomenon, or whether both are attributable to some unknown common cause.

The loadstone is frequently combined with substances which have small or no attractive powers; and the poles, or points of contrary nature with respect to attractions and repulsions, being irregularly distributed, counteract in part one another's effects: thus a mass of loadstone often exhibits a comparatively small adhesive force; and it happens at times that, when the mass is broken in pieces, some of the portions, containing a considerable quantity of the attractive material favourably disposed, exercise a greater power than was exhibited by the entire mass. It is found that a piece of loadstone will seldom suspend more than 5 or 10 times its own weight, though some small specimens have been obtained which are said to have suspended more than 200 times their weight.

If a piece of iron be placed in contact with either pole of a magnetised bar, the force of the coherence is that which is due to the direct action of that pole only on the contrary magnetism of the iron: the intensity is at least doubled when the substance to be suspended can be placed at once in contact with both poles; and this is frequently effected by giving to the magnetised bar the form of a horse-shoe, so that the opposite poles may be near one another: but the most effectual method of increasing the power of a magnetic body is that of *arming* it.

Preparatory to arming a piece of loadstone the situation of its axis, that is, of a line joining its poles, must be determined by trial: the loadstone is then reduced to the form of a cube or parallelopiped nearly, having two opposite faces perpendicular to the axis; and these faces are ground very smooth. Two plates of soft iron equal in length and breadth to these sides are applied to the latter so as quite to cover them, and are connected together by a bar of soft iron which is attached to them at the upper end of each (supposing the two plates to be in vertical positions): to this bar is affixed a hook or ring by which the whole apparatus may be suspended.

The inferior extremity of each plate is formed with a foot which projects under the loadstone, so that the latter may rest upon both; and horizontal bands of copper or silver usually surround the loadstone and side pieces in order to keep the whole together. Under the feet is applied a bar or plate of iron, touching both; and this is provided with a ring or hook from which is to be suspended the weight to be held by the attractive force of the loadstone. Artificial magnets have been armed in a similar manner.

The attractive powers situated in the poles of a natural or artificial magnet seem to be diffused over the two surfaces in which those poles are situated; and the plates of iron which cover those surfaces, serving to condense the powers, cause them to act with united energies in the two feet of the apparatus, by which means the power is greatly increased. The feet of the side plates should not however be made to approach each other too nearly; since in such position they would diminish each other's attractive powers.

It is found that a magnet when armed exerts a force more than one hundred times as great as that of the magnet in its natural state; and it has been ascertained that, after as much weight has been applied as the armed magnet will suspend, if at certain intervals of time other weights be added, the magnet will suspend two or three times as much as before.

Daniel Bernoulli discovered by experiment that the attractive forces of magnets vary in proportion to their superficies and not to their masses; a circumstance in accordance with Mr. Barlow's discovery respecting the magnetic attractions of iron spheres.

MAGNETIC ATTRACTION. [Magnet; Magnetism.]

MAGNETIC ELECTRICITY. A term employed to distinguish this force from Frictional Electricity, Voltaic Electricity, Thermo-Electricity, and Animal Electricity.

MAGNETIC INTENSITY. [Magnet.]

MAGNETISM. If we take a natural or an artificial magnet, and, spreading over a piece of paper a quantity of fine iron filings, place the magnet on the paper, on taking it up, we shall find that the iron filings are attached to it in some degree over all its surface, but they will be principally accumulated at two points situated near the ends of the magnet; these points are called the *poles* of the magnet. Sometimes when a magnetic bar is rolled amongst iron filings, we may find several such points along the bar; the magnet is then said to have *consecutive points.* At present we shall consider only the first or simple case of two poles, which we may represent by the letters N. and S. When a needle formed of this material is suspended horizontally on a pivot furnished with an agate cap for the purpose of diminishing friction, it assumes a particular direction, nearly north and south. [Magnet.] The pole N, at the north extremity of the needle thus adjusted, is commonly called the *north pole* of the needle; the other, S, the *south pole*, though the contrary names, as used by Dr. Gilbert, would be more correct in connection with the theory of magnetism.

If we now bring a piece of soft iron near the pole N, it will be attracted to that pole and become attached to it, so that the exertion of a mechanical force is necessary to separate them. In this way a magnet held vertically will sustain a piece of iron, provided the weight of the iron does not exceed the magnetic force. The pole S has a similar attractive power on iron; the cause of this attractive power is called Magnetism.

We have observed that in a magnetic needle placed horizontally on a pivot, the pole N is turned northwards, and S southwards, nearly: if such a needle be attached to a piece of cork floating on water, it will adjust itself to this direction, the deviation of which from the true north and south line is the *declination* of the needle. If now we invert the position of the needle, so that S is brought into the place previously occupied by N, and *vice versâ*, the needle and cork will make a complete revolution, and acquire its original position. Hence we see a distinction between the magnetisms *predominant* at N and at S; the former is called *Austral*, and the latter *Boreal* magnetism. It will be easy to observe the analogy between the mutual relations of the two magnetisms, and those of positive with negative electricities.

We must insulate a conducting electrised substance in order to preserve its electricity, but this is not necessary in the case of a magnet; each fragment of the latter is itself a magnet, possessing its north and south poles, and the same view may be extended to its constituent particles. A non-conducting energy, called the *coercive power*, exists therefore in magnetic substances, by which the loss of magnetism when developed is prevented, and by which also the poles N and S are situate in a determinate position relative to the body of the magnet. This is not the case with soft iron, which has not the coercive force.

The effect of the magnetic forces is considerably modified when substances which are capable of readily becoming magnetic by influence are situated near the magnet; and a similar effect takes place by the decomposition of the neutral electricities when under the influence of an electrised body. [Electricity.] The transmission of the magnetic force through interposed bodies may be observed familiarly by placing a common sewing-needle on a smooth horizontal board, and moving a strong magnet underneath the board: the needle will roll or revolve along the board according to the peculiar motions given to the magnet.

Let us next consider the action of magnets on each other. For this purpose make two magnets or magnetic needles to float on water, distinguishing the poles of one as before by N and S, and of the other by N′ and S′. Bring either the pole N near to N′, or S to S′: the needles or magnets will separate to a greater distance, and with the greater energy the nearer these poles are placed to each other. On the contrary, if we bring N and S′ near each other, the needles will approach and unite those points, and the same happens when the points N′ and S are made contiguous: hence this law—*magnetisms of the same name are mutually repulsive; those of contrary names are mutually attractive.* In the article Electricity, we have shown that the same law is true with respect to the two electricities.

The mass of the globe contains various sources of magnetism [Magnet]; and since a magnetic needle freely suspended acquires a determinate position, it follows from this law that the magnetism at the south extremity S is Boreal, that is, of the same name as the terrestrial magnetism which is predominant in the northern hemisphere, being repelled therefrom; and the magnetism at the north extremity N is for a like reason Austral. The law of magnetic force at different distances is expressed by the inverse square of the distance: one mode of verifying this law is by observing the times of the oscillations of a small fine wire, suspended in a plane perpendicular to the magnetic meridian (in order to neutralise the magnetising influence of the earth), and subjected to the action of a powerful magnet.

We can, by combining these laws, explain the manner in which soft iron, cobalt, and nickel are attracted or suspended by a magnet. These metals, when chemically pure, contain both the austral and boreal magnetism in a combined state, in consequence of their want of coercive power. When a piece of soft iron is brought near the pole N, which contains the austral fluid, the austral magnetism of the iron is repelled to the farther extremity, and the boreal attracted to the nearer extremity of the iron relative to the point N: this disposition of the fluid takes place immediately, and the law of force above announced relative to the distances causes the attraction of the fluid at N, on the boreal fluid of the soft iron, to exceed its repulsion on the austral, which is more remote from N: the total effect, in virtue of this excess, is therefore necessarily attractive. When the iron however is removed from this influence, its natural magnetisms again recombine. This will not be the case if, instead of soft iron, we use hardened iron or steel: the decomposition of the natural magnetisms takes place with greater difficulty, in consequence of the coercive power which protects their actual disposition; but if we use a powerful magnet at one extremity of a steel needle, or, which is more effectual, a pair of strong magnets at both extremities, the north pole of one and the south pole of the other being brought in contact with the needle, the decomposition will be partially effected, and will likewise be retained by the same coercive power which opposed its development; and agreeably with the magnetic laws of repulsion and attraction, that point of the needle in contact with the south pole will become a north pole of the needle, and the other a south pole. This method of producing magnetism is liable to the objections both of producing feeble magnetism and also producing consecutive points.

The quantities of the austral and boreal magnetic fluids in all magnetic bodies are equal; for when we bestow magnetic qualities on iron or steel by the influence of loadstones, hammering, sudden cooling in the magnetic meridian, &c., no new magnetism is communicated; but the natural magnetisms, which previously neutralised each other, are now decomposed. Again, if a magnetic needle be freely suspended by its centre of gravity, the action of terrestrial magnetism produces no linear motion, but only imposes a direction on the magnetic axis: now all the boreal fluid in the globe attracts all the austral fluid of the needle, and *vice versâ*, while the like fluids in both repel; hence a motion of progression would be generated, unless the resultant of the repulsive forces on the needle was exactly equal and of an opposite direction to the resultant of all the attractive forces; and the rotatory motion of the needle shows that the points of application of these forces are different; but the intensity of terrestrial magnetism may be regarded as uniform throughout the extent of the needle, and its direction parallel. In order therefore that the resultants should be equal and contrary, the sums of the boreal and austral forces of the needle must be equal. In this respect magnetism resembles the natural electricities of all substances.

The development of magnetism in bodies, whether by terrestrial action or the influence of loadstones, is analogous to the decomposition of the natural electricities in a system of conducting bodies separated by non-conductors under the influence of an external body and their own natural action: hence when magnetism is communicated by a loadstone, even when in contact, the latter loses none of its own magnetism, as it acts solely by influence; whereas in conducting electrised bodies, contact will communicate electricity: the coercive force of magnets therefore extends even to their surfaces. In fact the reaction of the substance magnetised by influence tends to a further decomposition of the fluids of the magnetising body, and this gives it greater energy, unless when it is magnetised to saturation, that is, when the internal magnetic forces are equal to the coercive power; for then any further development of the fluids would be only temporary, and a reunion would take place immediately.

The dipping-needle is a magnetic needle, the opposite poles of which possess equal magnetic intensities. It is attached to the centre of a vertical circle, and its motion is confined to the plane of this circle. The circle has a motion in azimuth about a vertical axis, and within a fixed horizontal circle, both circles being graduated. When the vertical circle is turned round its axis until the needle acquires a vertical position, the plane of the circle is then perpendicular to that of the magnetic meridian, and hence by means of the horizontal circle the position of this meridian plane becomes known. The vertical circle with the needle is now brought to coincide with the meridian plane, and the angular depression of the north pole of the horizon, or more strictly of the magnetic axis, may be read off the graduated limb of the vertical circle, and measures the dip. The right line joining the north and south poles of the needle is nearly coincident with the magnetic axis, but the latter may be ascertained more accurately by inverting the needle and taking the mean direction between its two positions of equilibrium. There are other methods of adjusting the dipping-needle, but in every method it requires great delicacy and minute attention to all parts of the adjustment.

If we place a bar of soft iron, suspended by a collection of silk strings at its middle, in a direction parallel to the magnetic axis of the dipping-needle, the action of terrestrial magnetism will have full effect on the bar, its natural magnetisms will be decomposed, and it will acquire a polarity similar to that of the needle, its poles repelling the similar poles of the needle, and attracting the contrary poles. Its want of coercive power prevents it from retaining the polarity of its different parts when the bar is moved into other positions; for if we invert the position of the bar, that point which was primitively the north pole will now become the south, and *vice versâ*, under the effects of a new decomposition of its magnetisms by terrestrial influence. If however the bar be left for a long time in the direction of the magnetic axis, or if it be heated to a red heat and suddenly cooled by immersion in water, it will acquire a coercive force, and become permanently magnetic. Iron crosses, weathercocks, &c., which have been long kept in a fixed position, or have been struck by lightning, acquire magnetic properties in the manner above described.

It is a remarkable circumstance connected with the change of molecular disposition caused by the action of heat, that if we gradually heat a bar of iron, the intensity of its action on a magnet increases, and arrives at a maximum when the bar is brought to a cherry-red heat, with higher degrees of heat the intensity is diminished, and is totally inappreciable when the bar has reached a bright white heat; on cooling it recovers its powers of action by similar steps, and the same law holds true if the magnet be heated instead of the bar. Hence in producing the greatest development of magnetism by influence, we see the advantage of using iron or steel bars at a red heat. [Lightning.]

Magnetism may be developed in iron, steel, cobalt, and nickel, by other means than the influence of bodies already magnetised, as twisting, hammering, electrical discharges, and galvanic currents. [Electro-Magnetism.] If we place a bar of iron in a vertical position, and give it a series of slight blows with a hammer or poker, it will acquire a feeble degree of magnetism; hence it happens that the anvils and other tools employed in smithies are endowed with magnetism. In all such cases the mechanical operations tend to bestow a coercive power, while the terrestrial magnetism separates the fluids in the body.

Cavallo, Benett, and Coulomb remarked the indications of magnetism given by various substances, as copper, silver, &c. It is particularly observable in hammered copper, and scarcely perceptible when the copper has been cast. Coulomb formed very fine needles of various substances, and suspending them by silk strings between the opposite poles of two powerful loadstones, found that they were acted on by the latter. This phenomenon was attributed to the existence of minute quantities of iron, or iron compounds in those different bodies, and the intensity of the magnetic action Coulomb found from direct experiments to be proportional to the quantities of iron contained in the bodies, and he afterwards applied this principle to discover the quantity of iron contained in impure metals. Faraday has however shown in the discovery of *diamagnetism*, that a much deeper truth was involved in the subject, as will be noticed more fully presently.

From the preceding observations on the properties of the magnetic fluids it will be easy to understand the principles upon which the various modes of constructing artificial magnets are founded, which we shall now briefly notice. The earliest method of magnetising a bar of hard iron or steel was by drawing it throughout its whole extent at right angles over one of the poles of a strong magnet. In this case if we suppose that pole which contains the austral fluid to be used, the first contact with the bar decomposes its neutral magnetisms, attracting to the point of contact the boreal and repelling the austral; the successive parts of the bar are subject to a similar decomposition of their fluids, but it is evident that the effect of each previous decomposition neutralises the succeeding, except at the extremities; the magnetism thus developed is therefore feeble, and apparent only at the extremities of the bars, or in some consecutive points formed by peculiarities in the material of the bar, or in the mode of operation. Dr. G. Knight greatly improved the mode of magnetising bars in the following manner: he joined two strongly magnetised bars by their ends bearing contrary names, and placing on them in the direction of their length a small steel bar heated to a cherry-red heat, with its middle on the point of junction of the magnetic bars, he made each of them to rub on the corresponding extremity of this steel bar, and the latter when removed was found to be strongly magnetised. In this method not only does the presence of the second magnet favour the decomposition of the magnetic fluids, but the intensity of the action of the magnetic forces is greatly increased by the elevated temperature of the steel bar.

Du Hamel placed two steel bars of equal length parallel to each other, connecting their corresponding extremities by pieces of soft iron interposed; then taking two bundles of magnetic bars, he united their poles of contrary name near the middle of one of the steel bars, and by inclining the bundles made one of them pass towards one extremity of the other bar, the second passing in the contrary direction, and then successively repeated the operation, when both the steel bars became strongly magnetised, but with contrary magnetisms at the corresponding extremities of each. In this method the decomposition of the neutral magnetisms of the interposed pieces of soft iron adds to the effect produced by the contact of the magnetised bundles with the steel bars.

Epinus, adopting a similar method, preferred interposing strong magnets instead of soft iron, the relative position of the poles of the two magnets being reversed; Coulomb combined the advantages of these different methods by composing his magnetised bundles of bars at a cherry-red heat. A fine steel needle may be very strongly magnetised by being placed in the axis of a wire twisted into the form of a helix, the extremities of which are brought in contact with the wires of a powerful galvanic battery. The poles of a bar magnetised to saturation are near its extremities, within generally a few lines, while the intensity becomes insensible at the distance of a few inches; in a thin bar the intensity may be represented by the difference of the ordinates of two logarithmic curves, the origin of one being at the austral, and of the others at the boreal extremity of the needle.

When bodies containing neutral magnetisms are made to rotate rapidly round an axis, the magnetism becomes developed and acts on the needle; thus a plate of copper made to revolve rapidly in a horizontal plane will influence a compass-needle placed over it, and produce in it a rotation in the same direction, on which subject several valuable observations have been made by M. Arago, Sir John Herschel, and others. It has also produced a second mathematical memoir from M. Poisson, in which the mechanical force generated by rotation is introduced into the general equations deduced from his theory of the distribution of magnetism in bodies. The phenomena are however now absorbed into Magneto-Electricity.

The consideration of the distribution of magnetism throughout the globe has led to various explanatory hypotheses since the time of Halley; the position, the number, and the motions of the points which may be regarded as poles of terrestrial magnetism, have been all subjects of discussion and of opinions formed on inconclusive grounds. But the consideration of this subject as well as an account of the dip, variation, and intensity, at different parts of the earth, as well as the consideration of the magnetic equator and poles, and the magnetic observatories that have been erected in different places will be best considered under Terrestrial Magnetism.

Some important discoveries in magnetism have been made of late years, and some knowledge has been gained as to the molecular changes produced by the magnetic condition. Mr. Joule has shown that a bar of iron in being magnetised increases in length, while its breadth diminishes. The greatest elongation observed by him amounted to the 180-thousandth of the length of the bar. He also states, that the elongation is proportional to the square of the developed magnetic intensity. He has also found that iron wires of a certain tension diminish in length instead of increasing, and that at a certain tension, there is no alteration in length. The sounds produced in making an electro-magnet are noticed under Electro-magnetism. *Circular magnetic polarisation* is a new and interesting branch of physical science, which we owe to the genius of Faraday. A few words on the subject will suffice here:—if in the course of a ray of light polarised by reflection, a bar of heavy glass (silico-borate of lead) be placed, it will be seen by a Nicol's prism that the ray is still polarised, and in the same plane as before. If, however, the poles of a powerful electro-magnet be brought near the bar of glass, in such a position that the direction of the ray through the glass is parallel to the straight line which joins the poles, a remarkable effect will be produced on making the electro-magnet. Supposing the Nicol's prism to be in the position of complete extinction, so that no light is transmitted through it, and the voltaic current be then sent through the coils of an electro-magnet, the light will immediately reappear through the prism, and will continue as long as the electro-magnetic force be maintained, and no longer. [Polarisation]. In the course of these researches, Faraday noticed that when the bar of heavy glass was suspended between the poles of the electro-magnet, no sooner was the magnet made, by connecting the coils with the battery, than the bar of glass ceased to swing indifferently, but moved round and took up a position at right angles to the direction that would be taken by a bar of soft iron placed in the same part of the magnetic field. The bar made a few vibrations round this position, and finally settled in it; and when displaced, it returned to it, and settled as before in this position, which Faraday calls the *equatorial*, to distinguish it from the position assumed by an iron bar under the same circumstances, and which he terms the *axial*.

On examining other bodies, it was found that every known substance when brought under the influence of a powerful electro-magnetic force, assumed either an axial or an equatorial position with respect to the poles. Faraday was led to regard all substances in nature as magnetic: those bodies which took up an axial position, or were attracted by the poles, he termed *para-magnetic*, while those bodies which were repelled, and consequently took up an equatorial position, he termed *dia-magnetic*. A piece of hæmatitic iron ore which is not acted on by an ordinary magnet will point axially when suspended between the poles of an electro-magnet; and a sheet of writing-paper rolled up into a short cylinder will also point axially in consequence of the minute portion of iron or of cobalt which it contains. The salts of the magnetic metals, when the latter form the base, were also found to be magnetic, such for example as crystals of proto-sulphate of iron, and solutions of such salts in water contained in a thin glass tube (the glass not being magnetic) assumed an axial position. Solutions of sulphate of nickel and sulphate of cobalt behaved in a similar manner and the salts of chromium and manganese were also found to be magnetic, whence it was inferred that the metals themselves are so. A stick of phosphorus assumes the equatorial position, as do also bismuth and antimony; and organic substances, such as slices of wood, apple, potato, flesh, &c. These are dia-magnetic, but not strongly so. Sulphur and india-rubber are decidedly repelled. Among liquids, alcohol and ether are dia-magnetic, and water still more so. Even the different gases and vapours were found to be acted on by the magnet, and among other modes of showing the action, soap-bubbles were blown with each gas in succession upon the end of a capillary tube, and being suspended near the pole of the magnet the circuit was completed, when the bubble was attracted or repelled according as the gas was magnetic or dia-magnetic. Oxygen was found to be powerfully magnetic: all other gases were found to be dia-magnetic, with the exception perhaps of nitrous oxide. Elevation of temperature was found to increase the dia-magnetic condition, a stream of hot oxygen being dia-magnetic in an atmosphere of cold oxygen. Faraday has suggested that this diminution of oxygen in magnetic intensity, as the temperature rises, may account in some way for the diurnal variations of the needle. A diminished pressure was found to lower the dia-magnetic force; the magnetic power of oxygen being diminished by a diminution of density. Nitrogen, which is a dia-magnetic, does not seem to undergo any change in its magnetic relations, by variations in density and temperature. In experiments of this nature the gases were enclosed in thin glass tubes in connection with a delicate torsion balance. The flame of burning bodies, as of a taper for example, when placed between the poles of the magnet is repelled towards either side, and even divides into two streams which pass off horizontally, one on either side, in the equatorial direction.

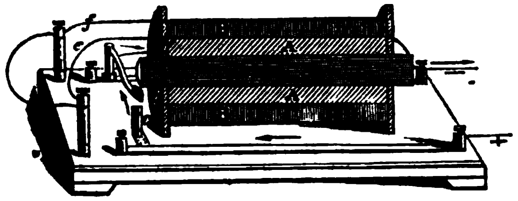
It is important to observe, that the nature of the medium in which a substance is placed, has an influence on the magnetic condition of matter; thus a rod of glass suspended horizontally in water, which is dia-magnetic, will point axially, but if the same rod be suspended in a solution of sulphate of iron, which is magnetic, it will point equatorially. So also, a tube filled with a solution of sulphate of iron, will appear to be magnetic if placed in pure water, but if placed in a stronger solution of sulphate of iron, it will be dia-magnetic. The same body may also be magnetic or dia-magnetic, according as it forms the base or electro-positive constituent of a compound, or the acid or electro-negative constituent. Iron for example, in the crystals of green vitriol acts as a base, and makes the crystals magnetic, but in the yellow prussiate of potash, where the iron is not a base but an electro-negative-constituent, the crystals are dia-magnetic; so also bichromate of potash is dia-magnetic, the chromium acting the part of an acid, while sulphate of chromium is magnetic, for here chromium acts as a base. Tyndall and Knoblauch ('Phil. Mag.' 1850), have shown that the arrangement of the component particles of a body will determine whether it be magnetic or dia-magnetic. For example, carbonate of iron is magnetic; if reduced to fine powder and formed into a cylinder by means of gum-water, it will point axially, but if compressed into a plate, this plate will set with its faces parallel to the equatorial direction. In fact, the parts brought nearest together by compression, were those which exhibited the dia-magnetic, or the magnetic action most strongly. In this way the phenomena, discovered by Plücker, were accounted for that in doubly refracting crystals the optic axis assumes a definite direction under the influence of the electro-magnet; for it is along this axis that the greatest condensation of the particles has probably taken place. There are many other remarkable circumstances connected with dia-magnetism, for which we must refer to Faraday's original memoirs, which have been published in a collected form, and also to Tyndall's papers, especially those in the 'Philosophical Transactions' for 1855, 1856, in which it is shown among other results, that the dia-magnetic repulsion, as measured by the torsion balance, is as the square of the intensity of the current.

MAGNETISM, ANIMAL. [MESMERISM.]

MAGNETO-ELECTRICITY. If a wire which joins the two ends of a voltaic battery [GALVANISM] and consequently through which a voltaic-current is passing, be arranged in such a manner as to be parallel with a second wire, the two ends of which are connected with a sensitive galvanometer, no action on the second wire will be perceived so long as the current is allowed to pass uninterruptedly through the first; but if the current through the first wire, called the *primary* current, be suddenly arrested by breaking off its connection with the battery, a current of momentary duration will be produced in the second wire; this which is called the *secondary* current is said to be direct, or in the same direction as that of the battery wire. On again connecting the first wire with the battery a momentary current or electric wave is again sent through the second wire; but it is now inverse or in a direction opposite to that of the primary current.

The term *volta-electric-induction* was applied by Faraday to these phenomena. Their effects may be augmented by employing coils in such a way that that which conveys the primary current, known as the *primary coil*, shall be placed in the axis of the coil in which the secondary current is generated, the ends of this the *secondary coil* being connected with the ends of the galvanometer. The moment the primary coil is connected with the battery the needle will receive a powerful impulse; but will regain its original position after a few oscillations, although the current through the primary coil is kept up; but no sooner is the primary coil disconnected from the battery than the needle will be powerfully impelled in an opposite direction. Similar phenomena may be produced if the primary coil, while connected with the battery, be made suddenly to approach to, or be removed from the secondary coil, in connection with the galvanometer. In approaching the coil the secondary current is inverse; but in withdrawing it, it is direct. If instead of the galvanometer, a small helix be connected with the secondary coil, a steel wire may be magnetised by the induction of these instantaneous secondary currents. If a Leyden jar be discharged through an insulated primary coil a secondary current will be generated in the other helix. Since then voltaic and frictional electricity may be made to produce magnetism, it was natural to suppose that magnetism could be made to produce electricity. We owe to Faraday the method of producing this result. An experiment will illustrate the conditions required to produce it. The ends of a copper helix are connected with a galvanometer by wires several feet in length in order that the instrument may not be directly acted on by the magnet which is to be employed. Now if a permanent magnet be introduced into the axis of the helix, a current in the wire is instantly produced, as marked by the deflexion of the galvanometer needle; if the magnet be kept at rest within the helix, the needle after a few oscillations returns to zero; but the act of withdrawing the magnet is sufficient to deflect the galvanometer needle in the opposite direction and to the same extent as before. The direction of the current depends on which pole of the magnet is introduced into the helix, and also upon whether the helix be left-handed or right-handed. On placing a bar of soft iron in the helix no current is produced; but if the opposite poles of two bar-magnets be brought in contact with the ends of the soft iron, a momentary current is produced.

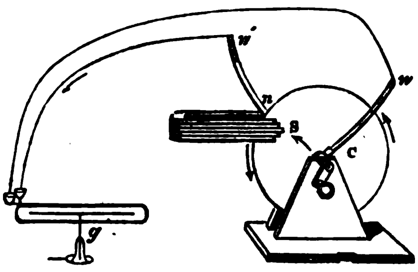
The secondary currents thus obtained by magnetic induction have considerable intensity, and if when the current is passing the circuit be broken a bright spark will be seen at the point of interruption. Ruhmkorff's coil is an improved form of apparatus for exhibiting these secondary currents. The primary or inner coil A A′ is a stouter and shorter wire than the secondary coil, B B; this is a very long thin wire insulated by silk, each layer of coils being carefully insulated from the adjacent ones. In a ten-inch coil the primary wire is 132 feet long, and the secondary wire 26,246 feet long. A bundle of soft iron wire, M, is placed in the axis of the coils, while at + and — are binding screws for connecting the primary coil with a voltaic battery. The primary coil is broken at *c* and *d*, *d* being a small armature of soft iron, faced below with platinum, the upper surface of *c* being also faced with platinum. When *c* and *d* are in contact the current circulates through A A; but in doing so the iron core M becomes magnetic, attracts *d*, the effect of which is to interrupt the current through A A, and the magnetism in M disappears; whereupon the hammer *d* falls upon *c*, the current through A A is again made to flow, *d* is again attracted, the current is again interrupted, and in this way the voltaic battery serves as a means for making and breaking the contact, and so rapid is the action that the hammer rises and falls several hundred times in a minute, and a powerful current is induced in the secondary coil B B by each of these momentary currents in A A, the effect of which is a continuous stream of sparks between the insulated ends of the secondary wire *e f*, and shocks of the most painful and dangerous character are produced. The power of the instrument may be greatly increased by connecting the primary wire with an arrangement called the *condenser*, consisting of oiled silk covered with tin-foil, folded between two other surfaces of silk and packed in a flat wooden case; the two coatings are connected with binding screws attached to *c* and *d* in the primary current. The effect of this condenser is to increase the intensity of the secondary current, so that with a large coil and careful attention to the insulation of the conducting wires, powerful sparks ten or eleven inches in length have been obtained. By means of this coil, electricity of low tension may be made to equal in intensity that of an ordinary plate machine, while the quantity is greatly increased. If the secondary coil be allowed to discharge in an exhausted receiver the phenomenon of the auroral light may be obtained in a very beautiful manner, through an interval of several feet. By arranging the discharge in various ways, as explained by Mr. Gassiot (Phil. Trans., 1858, 1859) in long tubes partially exhausted or containing gases of different kinds, the luminous portion is traversed by a series of dark bands, which are rendered much more distinct by the presence of a small portion of phosphorus vapour. [ELECTRICAL EGG.] The magnet has a powerful action on these stratified bands and luminous discharges.



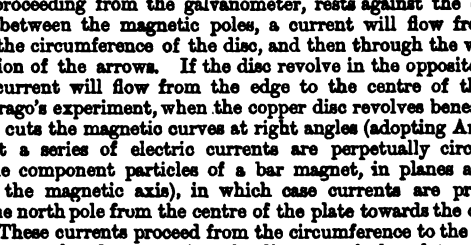
When the terminal plates of a voltaic battery are connected by means of a long wire coiled into a helix, a brilliant spark is produced on breaking contact, arising from a current passing through the wire in the same direction as that from the battery. The inductive action of the battery on the wire may be diverted by placing a second helix within the primary coil or exterior to it. By placing an iron core within the heliacal conducting wire the current becomes sufficiently intense on breaking contact to give a powerful shock, although the battery be of very small power. Professor Henry has shown ('Philosophical Magazine,' 1840) that a succession of induced currents may be formed by the action of coils upon each other. If, for example, the coil in connection with the battery be in the form of a flat spiral, and we call this A, and two other flat coils running into each other, namely, B and C, be arranged so that B shall rest on A and C on the table, there will be a momentary current in B and C every time the connection of the coil A with the battery is broken. If two other coils D and E, be arranged so that D shall rest on C and E on the table, the induced current in C will produce a current of the third order in D E. If a flat coil F be placed over E with its ends united by a small helix G, a current of the fourth order will be obtained. In this arrangement the secondary current B C will be direct; the current of the third order D E inverse; the current of the fourth order F G direct. The coils must be carefully insulated, and with care currents even up to the seventh order may be obtained, the currents being alternately direct and inverse. Similar currents are generated whenever the primary circuit is completed, but in such case the direction of the current is reversed. These induced currents give shocks, magnetise steel, and effect chemical decompositions.

Many years ago the motions of a magnet under the influence of a rotating copper-plate, known as "Arago's Rotations," excited considerable speculation and inquiry [MAGNETISM], until Faraday gave the true explanation. The leading experiment may be shown by suspending a bar magnet freely by its centre, so that it can move in a horizontal plane, while beneath it a circular disc of copper being made to rotate, the magnet will move round in the same direction as the disc, even though a sheet of paper or of glass be interposed between them. Discs of other metals on being rotated give motion to the magnet, but none so readily as copper. A narrow strip cut out of the disc, from the circumference to the centre, is sufficient to prevent the disc having any action on the magnet when the former is made to rotate. If the cut edges of the disc be connected by a piece of wire, the power of the disc over the magnet is completely restored.

In investigating these phenomena, Faraday found that when a conducting body is passed before the pole of a magnet, or between its opposite poles, so as to cut the magnetic curves at right angles, electrical currents are produced across the metal, transverse to the direction of motion. If, for example, the copper disc C, be made to revolve in the direction of the arrows at the edge, between the poles N S of a horse-shoe magnet, and a wire *w*, connected with one end of the galvanometer *g*, be pressed against the centre of the disc, while the other wire *w'*, proceeding from the galvanometer, rests against the edge of the disc, between the magnetic poles, a current will flow from the centre to the circumference of the disc, and then through the wires in the direction of the arrows. If the disc revolve in the opposite direction the current will flow from the edge to the centre of the disc. Now in Arago's experiment, when the copper disc revolves beneath the magnet, it cuts the magnetic curves at right angles (adopting Ampère's view that a series of electric currents are perpetually circulating around the component particles of a bar magnet, in planes at right angles to the magnetic axis), in which case currents are produced beneath the north pole from the centre of the plate towards the circumference. These currents proceed from the circumference to the centre, beneath the south pole, traversing the diameter of the plate, parallel to the magnet, and return by the more distant parts of the plate. Such currents exert a repulsive action on the magnet in a direction coinciding with the motion, and there are no currents until the magnet or the plate be in motion.



More convenient arrangements than the above have been contrived for the generation of magneto-electric currents, the best known of which is Saxton's *magneto-electric machine*. It consists of a powerful horse-shoe magnet placed horizontally upon one of its sides, and opposite and nearly in contact with its poles an armature of soft iron *a b* is made to revolve upon a horizontal axis A. In the figure the horse-shoe magnet is not shown. The armature consists of two pieces of iron, about 2 inches long, attached to a cross-piece of iron X, at such a distance as to be opposite the middle of each pole of the horse-shoe magnet. Each piece of iron, *a b*, contains a coil, *c d*, of fine copper-wire covered with silk to insulate the coils. The corresponding ends of each of these coils are connected together; one pair, *e f*, is attached to the spindle *s*, on which the armature revolves, and through it is connected with a circular copper disc, *i*, the edge of which dips into a cup of mercury, *m*, while the other pair of wires, *g h*, is connected with a stout piece of copper that passes through the axis of the spindle *s*, from which it is electrically insulated, and terminates in a slip of copper, *k*, which is placed nearly at right angles to the cross-piece X. Beneath *k* is a second cup of mercury, *l*, which can be made to communicate with the cup *m* by a wire or some other conductor. During the revolution of the armature, the points of the slip *k* alternately dip into the mercury and rise above it. Now when *l* and *m* are connected, and the point *k* beneath the mercury, the circuit is complete. The ends of the armature, *a b*, are exactly opposite the ends of the horse-shoe magnet, but by giving motion to the axis they quit that position, lose their magnetism, the current is broken, the slip *k* leaves the mercury, and in doing so produces a bright spark. If the connection between the mercury cups be made by means of wires, terminating in copper cylinders, held one in each hand, a rapid succession of powerful shocks will be felt on causing the armature to rotate. Water and saline solutions may be decomposed by transmitting these currents through them. For currents of high intensity, such as are required for these decompositions, the armature should be furnished with a great length of thin wire; but for the display of large sparks, and the ignition of platinum wire, &c., a shorter length of thicker wire may be used. It should be observed that the currents produced during each half revolution in the two limbs of the armature are in opposite directions, but in some machines arrangements are made by means of *commutators* [TELEGRAPH, ELECTRIC] for keeping up a continuous current in a uniform direction. This is of importance, since magneto-electric machines now often take the place of the voltaic battery in the electric telegraph, and in the process of electro-silvering, and electro-gilding [ELECTRO-METALLURGY]; and a powerful machine of this kind has been employed by Mr. Holmes for producing a light of great steadiness and intensity between two points of gas coke. This light has been experimentally and successfully tried at the South Foreland Lighthouse.



MAGNETOMETER. A name applied to those instruments, the function of which is to measure any of the magnetic elements. These instruments will be best described in connection with their subject, namely, TERRESTRIAL MAGNETISM.

MAGNIFYING POWER. [MICROSCOPE; TELESCOPE.]

MAGNITUDE. This term is generally used synonymously with quantity, and is sometimes even confounded with number. The distinction between the first two terms is not more marked than this: he who answers the question "how much?" describes the quantity, and he who answers "how great?" describes the magnitude. But since magnitude is generally used in our language as applied to amount of space, we may best describe our own idiom by laying down quantity as the general term, and stating magnitude to mean usually the quantity of space. The term however must be considered, in a mathematical point of view, as originating with Euclid (whose word is μέγεθος), and it is used by him, not particularly as applied to space, but also to everything which admits of the introduction of the notion of greater or less. In this sense, then, we have many magnitudes (all moral qualities, for instance) which are not the object of mathematical reasoning. So necessary is the notion of magnitude to our conception even of things which we cannot measure, that we borrow idioms from subjects within the province of mathematics. Thus we speak of force of mind, and of it being greater in one individual than in another. According to the definition of magnitude,—namely, "that of which greater or less can be predicated, when two of the same kind are compared together," it follows that we include both mental as well as material objects of conception. But the mathematics interpose the postulate that no such object can be made matter of exact reasoning, unless in cases which admit of the comparison being performed according to some method the results of which shall be self-evident, and inseparable from our notion of the thing measured. Let A and B be two magnitudes of the same kind; they are then, and then only, the objects of mathematical comparison, when other magnitudes equal to A and B can be found, and added together as often as may be desired; and when, moreover, any collection of A's can be compared with a collection of B's, so as to ascertain which is greater or less than the other. Angles furnish an instance of magnitude the conception of which is exceedingly vague in the mind of most beginners, but which takes precision and certainty in the course of mathematical study. Magnitudes, thus capable of comparison, are the objects of the doctrine of PROPORTION. [See also NUMBER; QUANTITY.] That part of geometry which precedes proportion considers only the simple alternative of equal or unequal, modes of inequality being necessarily deferred until after that consideration.

By the magnitude of any bounded space the mathematician means the results of measurement which will be described in SOLID, &c., DIMENSIONS; but the common idiom refers to that which the mathematician calls, for distinction, *apparent* magnitude. It is correct, in the common meaning of the term, to say, that a man at a little distance from the eye is larger than a remote mountain. In thus judging of objects, the angles which they subtend at the eye furnish the means of comparison. Experience, derived from the combination of sight and touch, teaches us how to make those deductions which are necessary before we can learn the absolute from the apparent magnitude.

It is soon found that an object, as it recedes, grows smaller; that is, subtends a less angle. It is also seen that the recess is accompanied by a loss of brightness and distinctness. The former is a consequence of the loss of light which takes place in its passage through the air; were it not for this, the same object would be equally bright at all distances; for though the quantity of light which enters the eye is diminished by increase of distance, yet the surface from which the light appears to proceed is diminished in the same proportion. The loss of distinctness is a consequence, first of the loss of light, next of the different proportion in which different colours are lost: the effect of the interposed atmosphere amounting to laying on more or less of the blue colour of the atmosphere over the whole. Our perception of magnitude depends both on the subtended angle and on the distinctness: we learn from experience, that of two objects seen under the same angle, the less distinct, as being the more distant, must be the larger. That habit is our guide can readily be shown by producing instances in which we are deceived, the object being either such as is not commonly seen, or seen under unusual circumstances. A colossal statue mounted on a column does not suggest the idea of a man of unusual size to persons in general, unless when some person mounts the same height and affords means of comparison. In a fog, which diminishes the distinctness of objects, but does not affect the angles under which they are seen, these objects are sensibly increased in apparent size; and distant hills appear nearer in a clear day than in a hazy one. Those who wear spectacles may satisfy themselves by breathing on the glasses, and watching an object as the moisture evaporates, that increase of distinctness gives apparent approximation.

The angle subtended by an object is inversely as its distance, which is sufficiently near for common purposes, when angles are small, which is generally the case; and a man of 6 feet high, at the distance of 100 feet, is seen under an angle of 3° 26′. The sun is seen under an angle of 32′, and the moon under an angle of 29½′ to 33½′.

MAHÂBHÂRATA, or **BHARATA** ("belonging to Bhârata and his descendants"), the most celebrated epic poem of the Hindus after the 'Râmâyana.' A passage in the introductory part of the work (1, 2296) has given ground for the assertion that it contains the round number of a hundred thousand distichs or slocâs; but in order to complete this enormous amount, the 'Harivansa,' a mythological history of Krishna, and sundry other pieces, have been added. The eighteen component fictions (Parva) of the 'Mahâbhârata' contain about 85,000 slocâs, and even these may be reduced to 24,000 distichs, of which the original 'Bhârata,' without its episodes, is said to have formerly consisted. (1, 101.) The principal subject of the 'Mahâbhârata,' to which its middle sections particularly are consecrated, is a long civil war between two dynasties of ancient India, the Kurus and Pândus. Both were descended from Bhârata, king of Hastinapur, whose first-born son, Dhritarâshtra the father of Duryodhana and the Kurus, ought to have succeeded to the throne; but this prince being blind, the sceptre was seized by his cousin Yudhishtiras, the eldest of the five Pându princes. At first the usurper was driven off by his uncle Duryodhana, and even banished to a wilderness for twelve years; but as the Pându brethren were favoured by their friend and ally, the heavenly Krishna, and as they were themselves, according to the legend, begotten by several deities, after a long struggle against the Kuru princes, and after many perilous adventures and bloody exploits, they were finally established in the sovereignty of India.

In this main texture of the 'Mahâbhârata' is interwoven a great variety of episodes; or more properly speaking, the history of the Pândus and Kurus is the leading thread by which an immense collection of ancient traditions, moral reflections, poetical descriptions, and popular stories of every kind, has been connected. It is very important to observe that these accessory elements, which now form almost three-fourths of the whole epopee, are stated in the poem itself not to be constituent parts of the original 'Bhârata;' in fact they are for the most part very loosely inserted; and as many of them are epic productions of considerable length, the principal theme is not only frequently interrupted by intervening episodes, but often totally lost sight of, even when the most active progression should be expected. Thus, for instance, the metaphysical system of Patanjali is propounded by Krishna, in the eighteen lectures of the much admired Bhagavadgitâ, just when the army stands disposed in full array and ready for battle. Besides a vast number of various short tales and fictions of every description occasionally inserted, the episodical compositions of the 'Mahâbhârata' may be divided into two general classes of a more distinct character and of peculiar importance. The first class, to which the early sections of the 'Mahâbhârata' are particularly consecrated, is occupied in solving theogonical and cosmogonical problems, blended with those wild and fantastical conceptions by which the metaphysical mind of the Hindus is so deeply attracted. To these, in the last chapters of the work, and after the conclusion of the great war, are added didactic and moral episodes on religious duties and sacrifices, on solitary and penitential life, and on final beatitude, forming almost a complete system of Indian ethics, and a compendium of the Brahminical faith. The second class of episodes, which may, although in some respect improperly, be called historical, consists of various and ample traditions of former epochs, and is occupied in recording the origin, genealogy, and history of ancient kings and heroes; in giving an account of their government and practice of warfare, their individual adventures, and their splendid actions; and in exhibiting their piety and devotion in fulfilling those duties of a religious life by which the favours of the heavenly beings are to be acquired. These and similar narratives are chiefly accumulated in the third and longest section of the 'Mahâbhârata,' called Vanaparvan (book of the forest), where they are told by the Brahminical sage Markhandeya, for the purpose of entertaining, consoling, and animating the dejected spirit of the Pandu princes during their exile in the wilderness. In this respect the episodical pieces of the 'Mahâbhârata' may be compared with the rhapsodies sung by Phemius and Demodocus in the Homeric poems, and as many of them are marked with a peculiar simplicity of manners and customs, they might almost seem of an older date than the main body of the epopee, of which they are totally independent. This leads us to the original composition of the 'Mahâbhârata,' which in the introductory part of the poem is thus related.

The most celebrated sages, with their disciples, being assembled at a splendid sacrificial festival, the venerable Krishna Dvaipâyana, with the surname of Vyâsa, who had been an eye-witness of the great civil war, is requested by king Janamejaya to give an account of those bloody events, in which, two generations ago, his own ancestors had played a fatal part. This task, being declined by Vyâsa himself, is readily performed by one of his disciples, Vaisampâyana, who being duly instructed, and from memory familiar with the heroic poem, recites it at full length to the listening assembly. A similar festival being afterwards celebrated by king Saunaka, the same proceedings are repeated, and Sauti, whose father had been a disciple of Vyâsa, undertakes the recital of what is now considered the original 'Bhârata.' Neither in these nor in other instances is a written copy of the text mentioned; it was in fact only committed to memory and handed down by oral tradition, until the increasing mass of subsequent episodes, more or less connected with the primitive subject, urged the necessity of a final arrangement; and, to avoid further interpolations, a summary of the contents was prefixed to the whole collection, now existing under the name of 'Mahâbhârata.' Notwithanding the traditional character and the gradual growth of the poem, Vyâsa has been supposed not only its author, but even the operation of collecting its component parts has been attributed to him, as it was he who, according to Hindu tradition, collected the Vedâs and Purânâs, and composed the Brahmasûtras of the Vedântine school. But as these operations could not be executed by the same individual, it has long been acknowledged that the name of Vyâsa (implying *disposition*) does not signify a distinct historical person, but rather an allegorical character, including the important fact that the four great parts of the sacred canon were digested by the same orthodox body of the ancient Brahminical schools, by whom almost every branch of the traditional and scientific learning of the Hindus has been successively propagated and preserved. Hence a religious and priestly character prevails in the epic poetry of the Hindus; in this sense the 'Akhyâna' is often styled a fifth 'Veda,' and the 'Râmâyana,' as well as 'Mahâbhârata,' are in fact considered as the 'Sâstra' of the Kshatriya caste, for whose recreation, encouragement, and instruction they were originally designed. Compared with the 'Râmâyana' the 'Mahâbhârata' is wanting in unity and internal coherence; it is rather a collection of ancient epic poems, gathered round the central history of the Kurus and Pândus: but for this very reason it far surpasses the former poem by a greater variety of pleasing scenes and attractive situations, particularly in its episodes, the characters of which are very often delineated with so peculiar a delicacy, and with so strongly marked an individuality, as to leave a powerful impression on the reader. Finally, and what is more essential, the 'Mahâbhârata' may be looked upon as a most ample source of every kind of antiquarian lore, and as the only Sanskrit work, if we except the 'Annals of Kashmir,' by which a considerable quantity of the most valuable historical fragments has been preserved. The truth of this will be shown in a series of learned essays lately begun by Prof. Lassen (in 'Zeitschrift für die Kunde des Morgenlandes'). The great war itself, which on astronomical calculations has been supposed to have taken place during the 12th century B.C. (Works of Sir William Jones, iii., 213; vii., 77), is indubitably an historical event; and as Pându (white), Krishna (black), Duryodhana, Dhritarâshtra, and other names are allegorical, Prof. Lassen acutely suggests, that the war might be the long and serious contest between the Brahminical tribes and the native occupants of the country. Leaving aside these questions, we only remark that although the 'Bhârata,' properly so called, is by no means contemporary with the events described in it, its pretensions to a very remote period of Hindu antiquity are sufficiently justified by internal evidênce and the unanimous testimonies of subsequent writers. The poem is evidently of later date than the 'Râmâyana,' but neither the precise time in which it was composed, nor even the epoch of its finally assuming its present shape, can yet be ascertained.

A complete edition in the original Sanskrit, carefully collated by learned Pundits with the best manuscripts in the library of the Sanscrit College of Calcutta, has been published by the Asiatic Society of Bengal, in four volumes royal 4to., with an index in a separate volume, the last of which was issued in 1839. A number of detached fragments and single stories of the 'Mahâbhârata,' have been faithfully translated by Sir Charles Wilkins, Prof. Wilson, and Mr. Milman, such as 'The Churning of the Ocean,' the 'Story of Dushwanta' and 'Sacuntalâ.' This last has also been issued in a most splendid form from the press of Mr. Austin, of Hertford, freely translated in prose and verse, by Monier Williams in 1855; it has also been translated into French and German ('Annals of Oriental Literature;' 'Oriental Quarterly Magazine,' 1825; 'Quarterly Review,' vol. xiv.). The following episodes also have appeared in the original Sanskrit: 1. 'Nala and Damayanti,' published by F. Bopp, Lond. 1819; Berlin, 1832. Translated into English verse by H. H. Milman, Oxford, 1835. 2. The 'Bhagavadgitâ,' by A. W. Schlegel, Bonn, 1823. An English prose translation was published by Sir Charles Wilkins, London 1785. 3. 'Indralokâgamanam,' 'Hidimbabadha,' 'Brâhmavilâpa,' 'Sundas and Upasunda,' and Tilottamâ,' by Bopp, Berlin, 1824. 4. 'Diluvium cum tribus aliis Mahâbhârati præstantissimis episodiis,' by Bopp, Berlin, 1829.

MAHOGANY: ECONOMICAL USES. This wood was first known in England in 1724, when Dr. Gibbons, a physician residing in King Street, Covent Garden, received a few planks from his brother, a captain in the West India trade. After much trouble, occasioned by the wood being too hard for the tools generally used by carpenters and cabinet makers, a candle-box and a burêau were made, and excited much admiration for the beauty of the wood. The fact became known, more planks were procured, and the cabinet-maker employed realised a fortune by making articles of furniture in mahogany. From that year this wood began to supersede walnut and pear-tree in the houses of the rich.

The mahogany forests are chiefly in Cuba and Central America. The tree grows to so large a size, that logs of six or seven tons are frequently imported. The cost is chiefly made up of the expenses incident to the conveyance of such vast masses to the shipping ports, in countries where roads are few and the means of traction defective. The season for cutting commences in August. The men work in gangs of from fifty to a hundred each, under a *huntsman* to search out the best trees, and a *captain* to regulate operations. They determine on a sufficient number of trees to employ the whole gang during the season. Each tree is cut about ten or twelve feet from the ground, a stage being erected on which the men stand. The trunk is preferred for large timbers, but the branches for more beautiful grain, knots, curls, &c. The men live meanwhile in some sort of temporary village near a river, and construct a road from thence to the spot where the trees lie, often through dense forests of other kinds of wood, such as the bullet-tree, iron-wood, red-wood, and sapodilla. Their labour is exceedingly heavy, for many miles of road have often to be made, by clearing away the underwood with cutlasses, lopping down the trees with the axe, destroying the larger trunks by fire, levelling hillocks, and blasting rocky ground. By about December the roads are made: and the mahogany trunks are cut crosswise into logs, each of such size that a bullock-train can draw it. The largest log ever cut in Honduras is said to have been 17 feet long, 57 inches broad, 64 inches deep, and 15 tons weight; on account of its beauty and value it was left of unusually large size, and additional oxen were set apart to draw it. When reduced to logs by cross-cutting, the mahogany is brought from the round to the square shape, by the axe. These operations being finished by March, the two dry months of April and May are employed in dragging the timber to the river. The trucks employed require each seven pairs of oxen and two drivers; and the logs are placed upon them by being dragged up a temporary inclined platform. To avoid the great heat of the sun in that climate, the loading and carrying are conducted at night, by torchlight. Arrived at the river, the logs are set afloat; and when the rainy season of June has commenced, they are floated down to Belize or some other fort, the gangs rowing down in flat-bottomed canoes, and guiding the logs in their course.

When brought to England or any other market, the price varies extremely, being dependent partly on the size of the logs and partly on the beauty of the wood. When a log is fine enough to be cut up into broad and beautiful veneers, it will bring a high price. Some years ago Messrs. Broadwood, the eminent pianoforte manufacturers, gave a higher price than has ever been known before or since for three logs of mahogany: namely, 2000*l.* Each log was 15 feet long by about 38 inches square. When cut into veneers of an eighth of an inch, the wood was peculiarly beautiful, susceptible of receiving the highest polish; and when polished, it reflected the light in a very varied manner, like the surface of a crystal. The general figure of the grain resembled the ripple or small waves of water gently moved by the wind; and on this account the wood, which for twenty years was employed for veneering some of the more costly pianofortes, obtained in the factory the name of *ocean-wood*. In this special example, the wood was *Honduras* mahogany; but in the general state of the market the *Spanish* is a finer kind, and brings a higher price. As a sort of average, Spanish mahogany is in logs about 10 feet long by 20 to 26 inches square; while Honduras is 12 to 18 feet long, and from 2 to 4 feet square. Specimens of Honduras mahogany have come to market from which planks 7 feet in width could be cut. *African* mahogany twists more than Spanish or Honduras, and is inferior to them in most qualities except hardness. Mahogany warps less, and holds glue better, than most other kinds of wood, and on these accounts is much valued for cabinet work, besides its largeness of size and beauty of appearance.

From a paper read before the Society of Arts in 1859, by Mr. Leonard Wray, it appears that there are eight kinds of wood which are ranked 'first class' at Lloyd's as employed in shipbuilding; twenty others are ranked as 'second class,' including mahogany. The finest quality of mahogany is too costly to be used for the large timbers of ships, while the cheaper qualities are not good enough. That good mahogany is a magnificent wood for shipbuilding is, however, well known. A Spanish 80-gun ship, built of mahogany, was captured by the English in 1757; and her timbers, more than a century old, were found to be perfectly sound. Her Majesty's beautiful steam yacht, 'Victoria and Albert,' is built almost wholly of mahogany; and there is an increasing use of this kind of timber by shipbuilders.

The uses of the mahogany tree for other purposes than its timber are too few to need description here.

MAIL (from the French *maille*), strictly "the mesh of a net," but applied in a collective view to defensive armour formed of iron rings or round meshes. Boyer, in his French dictionary, translates *maille* "a little iron ring." In the ancient armour the habergeon and hauberk were called coats of mail. [ARMOUR.] Mail or malle was also the name given to a bag or small sack, at first probably because made of net-work; since applied likewise to the portmantle or portmanteau.

MAIM (in law, "mayhem") is an injury done to the body of a man by forcibly depriving him of the use of some member serviceable in fight, as a means either of defence or offence, and permanently disabling him from offering such an effectual resistance to further attacks upon his person as he otherwise might have done; as if a foot, hand, or finger, or a joint of the foot or hand, be struck off or made crooked or weakened, or if a bone of the head be removed, or a fore-tooth broken or displaced, or if an eye be beaten out, or if any other bodily injury be inflicted whereby the party is rendered less capable of making a vigorous defence. But destruction of a jaw-tooth, of an ear, or of the nose, or of other members, the loss of which does not interfere with the means of defence or offence, does not amount to mayhem. The distinction however is by statutory alterations in the law rendered of little importance.

Mayhem was formerly punished by inflicting the same privation upon the offender which he had caused to the party maimed. It was afterwards punishable by fine and imprisonment, as an aggravated trespass. But now, by 7 Wm. IV. and 1 Vict., c. 85, to stab, cut, or wound, if with intent to murder, is a capital felony, and if with intent to maim, disfigure, or disable, is a felony punishable by transportation for life, or for not less than 15 years, (for which penal servitude is now substituted) or by imprisonment not exceeding three years. The statute 9 & 10 Vict., c. 25, makes it a felony to maim by the malicious explosion of gunpowder or other explosive substance; so also by the same statute it is a felony maliciously to cause any gunpowder or explosive substance to explode, or to send to any person any dangerous or noxious thing, or to throw any corrosive fluid or other destructive substance at any person with intent (*inter alia*) to maim, and these offences are now punishable by penal servitude for life, or imprisonment for three years.

Concurrently with these proceedings in the name of the crown, for the purposes of public justice, the party injured is entitled to compensation in the shape of damages, to be recovered in an action of trespass; and where the damages found by the jury are not commensurate to the injury sustained, the court may increase them upon inspection of the mayhem.

MAINTENANCE is defined to be when a man maintains a suit or quarrel to the disturbance or hindrance of right; and if he who maintains another is to have by agreement part of the land or debt, &c. in suit, it is called Champerty. Maintenance was an offence at common law, and has also been the subject of several statutes. By the 32 Hen. VIII., c. 9, no person shall bargain, buy or sell, or by any means obtain any pretensed rights or titles to any lands, unless he who bargains or sells, or his ancestors, or they by whom he claims the same, have been in possession thereof, or of the reversion or remainder thereof, or taken the rents and profits thereof, by the space of a year next before the bargain or sale, on pain of the seller forfeiting the whole value of the lands so bargained or sold, and the buyer, knowing the same, also forfeiting the value of such lands. The professed object of the statute, was to prevent the inquietness, oppression, and vexation which the preamble mentions as the consequence of the buying of titles and pretended rights of persons not being in possession of the lands sold. By the 8 & 9 Vict. c. 106, rights of entry may however be assigned or charged by deed.

A man may assign his interest in a debt after he has instituted a suit for its recovery, and such assignment of itself is not maintenance. But if the assignment be made on condition that the assignee prosecute the suit, or if the assignee give the assignor any indemnity against the costs of the suit, already incurred or to be incurred, this makes it maintenance.

(Comyn's *Digest*, 'Maintenance.')

MAINTENANCE, SEPARATE. [SETTLEMENT.]

MAIZE, or *Indian Corn*, is a plant commonly cultivated in the warmer parts of the world, where it answers a purpose similar to that of wheat in more northern countries. It is the *Zea Mays* of botanists, a monœcious grass, of vigorous growth, with stems not more than two feet high in some varieties, and reaching the height of eight or even ten feet in others. The leaves are broad, and hang down from large rough sheaths which surround the stem. The male flowers grow in loose, terminal, compound racemes, standing clear of the leaves; the females are arranged in numerous rows on a spike, which is wrapped round by several folds of sheathing bracts, which press upon the grains and give them the flattened figure they eventually acquire when ripe. Each grain has a long thread-like style, which projects beyond the enveloping sheaths; and as there are some hundreds of them upon each spike, the whole form a long tassel, which looks as if made of silk. The ripe grains are regularly arrayed one over the other in rows, are compressed at the sides, flattened at the apex, and of various colours. Their most common colour is pale yellow; some are white, some party-coloured, and there are varieties with blood red and even purple grains. A plant generally bears two full ears, the grains of which vary greatly in number: some of the largest ears in America contain at least 800 grains.

This plant in its wild state is met with in Paraguay, according to Auguste de St. Hilaire. It was also found on the continent of North America by the Europeans on their arrival there.

It seems that there is a particular line on the continent of Europe north of which the maize does not thrive. To the south of this line, which passes through Nancy, formerly the capital of Lorraine in France, it has in a great measure superseded wheat and rye as the common produce of the land. The bread made from maize is not so palatable as wheat or rye bread; but by mixing it in certain proportions with wheat it makes a very pleasant food. In the United States of North America, Indian corn forms almost the only bread eaten by many of the people; and in the slave-states it is the only bread that the negroes eat. It is not however in the shape of baked bread that maize is most generally used in Europe, but in boiled messes and soups, as peas are with us: it is not only the ripe grain which is eaten, but the ear in every state, from that of a green vegetable to an unripe corn. It is boiled, stewed, and baked: it is a substitute for cabbage or green-peas in its early stage; and is used in some way or other to its complete maturity. Nothing can be better than ripe maize to fatten hogs or poultry with; and the young stem cut down quite green gives one of the best and most abundant varieties of green food for cattle.

A plant which gives such a return cannot be expected to ripen its grains in poor land, or without attentive cultivation. The land must be naturally fertile, or made so by art; it must be well prepared to receive the seed, and sufficient manure must be given to recruit it. A light, moist, and warm soil suits this plant best. It thrives well on land broken up from grass, as is the case with most plants. As it is always sown in rows, and the plants thinned to a considerable distance, the intervals may easily be ploughed, or stirred with the horse-hoe, by which means the weeds are kept down, and the earth fertilised by exposure to the air. The seed should be taken from the largest and best formed ears; those at the end should be rejected, as less perfect. They should not be taken off until they are wanted for sowing, and then steeped in water to soften them. If the seed were steeped in brine and dried with quicklime, as is usually done with wheat, it might probably be advantageous, as this grain is subject to smut and brand as well as wheat; but this is not often done. The time for sowing maize in the south of France is the month of April; farther north it is sown later for fear of frost, which would entirely destroy the plant on its first appearance above ground: this is one of the reasons why it could not safely be sown in England before the middle or end of May, and it could scarcely be expected to ripen its seeds before the winter's frost set in.

The distance between the rows of maize varies from two to four feet. In good ground the latter distance has produced the heaviest crop. The seed is sometimes sown in the furrow after the plough, and sometimes put in with a dibble. The latter seems the best way, and, as the rows are wide and the seeds need not be put in nearer than a foot apart in the rows, an acre will be soon dibbled by hand. Two or three inches deep is sufficient to make the seed germinate readily. In warm moist climates the plant is very soon above ground. In fine weather, and when the seed has been steeped, it will be above ground in five or six days. When the plants are three or four inches out of the ground, and no frost is feared, they are thinned out to two feet apart, and in very rich soils three feet is better. In this case three or four ears may be expected to ripen on each stalk. In thin soils on a retentive subsoil the earth is raised in ridges, or, what is better, in mounds, by crossing the ridges with the plough, and three or four seeds are put into each hillock, which are two or three feet apart. As the plants rise, only one, or at most two are left in each hillock, and the earth is carefully moulded up to the stems; thus a deep dry bed is provided for the plant, and there is sufficient moisture from the impervious subsoil. This method might perhaps be adopted with advantage in England, in experiments on maize, where the situation admits of its cultivation. Maize, however sown, must be repeatedly hoed. At the first hoeing the plants which are too close are pulled up, and where there is a deficiency they are planted in: at least, this is the practice in Europe; but in America the general practice is to plant fresh seeds in the vacant places. When the plants are a foot high there is a second hoeing, the weeds are then cut up, and some earth is drawn towards the plants and raised around the stems. The reason of this is, that there are several joints very near each other at the bottom of the stem, and from each of these fibres strike out into the soil which is brought into contact with it, and form additional roots to the plant, as they do from the crown of the roots of wheat. When the flowers are ready to expand, a third hoeing is given, to kill weeds and open the surface of the soil slightly. The earth which is raised around the stems should be flattened a little at top, and even slightly hollowed out near the stem, to collect the dews and rains in dry seasons. If any tillers or shoots appear from the bottom of the stem they should be carefully removed, as they diminish the nourishment which should go to the main stem. A fourth hoeing and earthing up, at the time when the seed begins to swell, is useful, but seldom given, for fear of unnecessary expense. In many countries they sow or plant various vegetables in the intervals between the rows of maize, of which the most advantageous are turnips and cabbages, which may be sown or planted between the maize, after the last hoeing. French beans, except they be dwarfs, are not so proper, as they shade the maize and prevent its maturity. In warm climates cucumbers and melons are often raised there. In Carolina, where they hoe their maize only twice, a running weed springs up rapidly, which is much relished by cattle, and is cut several times before winter.

The time of flowering is very critical for the maize: a cold damp atmosphere may make a great part of the crop fail. In situations where this is to be feared, it is safe to sow maize at several times, with a week's interval: thus the risk is divided, and it is not so likely that the whole crop will be in flower in ungenial weather.

The male flowers, just as they expand, are excellent food for cattle; and it is usual in many places to cut off a great portion of them for this purpose. If it be done judiciously, there is no danger, provided a sufficient number of male flowers be left to impregnate the females: one in a square of about fifteen or twenty feet is thought sufficient. After the seed is set it is customary, in many places, to cut off the whole top of the stem, with the upper leaves, and give them to the cattle; but this is by no means to be recommended: the wound thus made bleeds, and much of the sap is lost. Besides, the upper leaves serve to elaborate the sap and assist its circulation; they should therefore be left on as long as they are green, and other food found for the cattle.

All plants which stand too close or have no ears upon them should be pulled up and given to the cows, to give air to the rest; all those also that are very late and have abortive ears should be taken up, as they would at all events not ripen their seed. The young ear is preserved as a pickle, like young cucumbers: when a little advanced it is roasted on the coals, or before the fire, and is pleasant to eat: in the green state, when the grains are still soft and milky, it is boiled, and used as a vegetable, and is considered a delicacy.

Maize is subject to diseases similar to those of wheat and other grain; and it is supposed, as observed before, that the steeping and liming may prevent them in a great measure.

When the maize is fully ripe, which it is not until the sheath of the ear opens and appears quite dead, the ears are twisted off by hand and laid in a dry place; they are turned occasionally that the sheath may not become musty, and are then stored in a dry place: the seed keeps better so than when it is separated. The taking off the seeds from the ear is a laborious operation; it may be done by the flail, but is most easily accomplished by an old blunt sword or iron hoop fixed over a tub. The ears are rubbed hard over this edge, and the seeds fall into the tub. They have a simple machine in America, which does the work quickly. The core or rachis is only fit for burning in the oven. The leaves are gathered for fodder a short time before the ears are pulled. In America and in Italy they stuff mattresses with the dry sheath, which makes a cool and elastic bed.

All animals are fond of maize, especially horses, pigs, and poultry; it gives the flesh of the two last a peculiarly fine flavour. The most profitable way to use maize in fattening animals is to grind it into meal, and mix it with warm water into a pottage; and, for horses, to soak it twenty-four hours in water before they are fed with it. In the dry state it is so hard that it wears their teeth, and in young horses is apt to produce blindness by the exertion of the muscles of the jaw in chewing it.

One of the most important uses of maize in Europe is to sow it thick, to be cut green as food for cows, oxen, and sheep. In a proper climate there is no plant which gives so great a mass of green food as maize. The produce is most abundant and nutritive. The largest varieties should be chosen. The seed may be sown in drills in April, and in September a crop might be mown, which would give admirable fodder for every kind of cattle. It is said to exhaust the land; but what will not exhaust it, more or less, which gives much nourishment? Maize will well repay the manure which may be required to restore the humus it has consumed. If it is sown early, a second crop may be raised the same year; for it does not spring up again, like grass, after being cut. Where the land admits of irrigation, the growth of the maize is most rapid and luxuriant. The time to cut it is when the male flowers are just appearing out of the sheath in which they are enveloped in the early stage of their growth. It may be dried into hay, and will keep good for a couple of years; but in this state it must be bruised or soaked when given to cattle, as the stems get very hard in drying; they may however be cut, as the cane-tops are in the sugar-plantations.

MAJOR (Latin), *Greater*, in music, a term applicable to the imperfect concords, but chiefly to the interval of the 3rd. It is also used to distinguish the mode which takes a major or sharp 3rd, from that having a minor or flat one. The *major* mode has always a greater 3rd —that is, a 3rd consisting of two tones; and the minor mode has always a minor 3rd—that is, a 3rd consisting of a tone and a semitone. [KEY; MODE; THIRD.]

MAJOR, a field-officer next in rank below a lieutenant-colonel, and immediately superior to the captains of troops in a regiment of calvary, or to the captains of companies in a battalion of infantry. His duty is to superintend the exercises of the regiment or battalion, and, on parade or in action, to carry into effect the orders of the colonel. The major has also to regulate the distribution of the officers and men for the performance of any particular service; and he has a temporary charge of the effects appertaining to any individual of the corps, in the event of the absence or death of such individual.

This class of field-officers does not appear to have existed before the beginning of the 17th century; and, at first, such officers had the title of *serjeants-major*, a designation borne at an earlier time by a class corresponding to that of the present majors-general of an army. (Grose, vol. i. p. 243.)

No mention is made of either lieutenants-colonel or majors as field-officers in the account of Queen Elizabeth's army in Ireland (1600). But Ward, in his 'Animadversions of Warre' (1639), has given a description of the duties of the latter class, under the name of serjeants-major, from which it appears that those duties were then nearly the same as are exercised by the present majors of regiments. They are stated to consist in receiving the orders from the general commanding the army; in conveying them to the colonel of the regiment, and subsequently in transmitting them to the officers of the companies; also, in superintending the distribution of ammunition to the troops, and in visiting the guard by day or night.

A brigade-major is a staff-officer who performs for a brigade, or in a garrison, duties corresponding to those of a major in a regiment or battalion.

A serjeant-major of a regiment is a non-commissioned officer, who in general superintends the military exercises of the soldiers: on parade, he has the care of dressing the line.

MAJOR-GENERAL. [GENERAL.]

MALAMIC ACID. [MALIC ACID.]

MALAMIDE. [MALIC ACID.]

MALANILIC ACID. [MALIC ACID.]

MALATES. [MALIC ACID.]

MALE FERN, the rhizoma, incorrectly termed root, of the Nephrodium Filix Mas (Richard), Aspidium Filix Mas (Smith), has been celebrated from ancient times as an anthelmintic. The rootstock of young plants should be collected in spring or summer, and a fresh supply obtained every year, as a change occurs in the part a few months after being collected. It should be quickly dried, and preserved in glass or earthenware vessels in a dry place. The interior should exhibit a greenish colour, and possess a disagreeable odour, with a bitter harsh astringent taste. Male fern buds have the same properties.

The rhizoma contains a volatile oil, which may be extracted by sulphuric ether; resin, tannin, uncrystallisable sugar, starch, and woody fibre. The oil, which is of two distinct kinds, one pure, and the other united with resin and an extractive, is the active principle. Formerly a powder of the whole substance was administered, but as the dose of this is bulky, Peschier has recommended pills of ethereal extract, which are found to be very efficacious against that kind of tape-worm which is denominated the *Bothriocephalus latus*, or broad tape-worm. It is scarcely possessed of any power over the Tænia solium. The former infests the small intestines of the inhabitants of Poland, Russia, Switzerland, and some districts of France, in all which countries the male fern has a high reputation as a remedy; but it is not much valued as an anthelmintic in Britain, where the broad tape-worm is nearly unknown.

MALEATES. [MALEIC ACID.]

MALEIC ACID ($C_8H_4O_8$). An organic acid, prepared by the dry distillation of malic acid. It crystallises in oblique rhomboidal prisms, which are colourless and inodorous, and possess a nauseous but acid taste. They are soluble in water, alcohol, and ether, and the solution reddens litmus. Heated strongly, maleic acid is converted into anhydrous maleic acid ($C_8H_2O_6$). When long boiled it is converted into fumaric acid, which is isomeric with maleic acid; and finally, when the lime salt is placed in contact with putrid cheese, it is converted into succinic acid. It unites with bases to form *maleates*.

MALIC ACID ($C_8H_4O_8$, 2HO) was discovered in 1785 by Scheele. It received its name from having been first obtained from the juice of apples, in which it exists in considerable quantity, and also, as has been since ascertained, in various other fruits, as cherries, raspberries, strawberries, in house-leek, and the berries of the sorbus or mountain-ash. Mr. Donovan, who procured it from the last mentioned source, obtained it of so great purity that he supposed it to be a new and peculiar acid, which he called sorbic acid; but it has since been proved to be identical with the malic. A mucilaginous substance which accompanies the acid obtained from apples prevents its properties from being perfectly and readily developed.

Various processes have been proposed for procuring this acid, and they are generally complicated: the following, proposed by Liebig, is perhaps as good as any: Add carbonate of lime, but not to perfect saturation, to the expressed juice of the mountain ash; the solution is to be decomposed by nitrate of lead, which precipitates malate of lead; this, after washing with cold water, is to be heated with boiling dilute sulphuric acid, and the resulting mass with sulphide of barium, by which there are formed sulphide of lead and sulphate of baryta, while the clear liquor contains malic acid, to which ammonia is then added to convert it into bimalate of ammonia, which readily crystallises; this salt is to be precipitated by acetate of lead, and the resulting malate of lead decomposed by hydrosulphuric acid; the clear liquor, separated from the sulphide of lead, being evaporated by a gentle heat, yields crystals of malic acid, which are not however regular in their form. Malic acid is colourless, inodorous, very sour to the taste, and acts strongly on vegetable blues; in a moist air it is deliquescent; it is very soluble both in water and alcohol. Nitric acid converts it into oxalic acid. Its saline compounds are called malates, some of which exist in nature, as for example, bimalate of lime in the juice of the houseleek.

When malic acid is subjected to a heat of about 350° Fahr., it is decomposed into water and two isomeric pyro-acids, the maleic and the fumaric acids.

The malates are not an important class of salts. We shall mention the general properties of a few of them. They may be divided into two classes, namely:—the neutral malates which have the formula $C_8H_4O_8$, 2MO, and the bimalates consisting of $C_8H_4O_8$, MO HO.

Malate of ammonia is a deliquescent salt, but the bimalate is crystallisable, unalterable in the air, and insoluble in alcohol. Malate of potash is a deliquescent mass; the bimalate forms crystals which are unalterable in the air and insoluble in alcohol. Malate of soda is a deliquescent mass, the supermalate crystallises. Malate of lime is sparingly soluble in water, requiring 147 parts of it cold, and 65 when boiling: the hot solution deposits crystalline grains on cooling. It is stated to be more soluble in some saline solutions than in pure water; the bimalate occurs in houseleek and some varieties of *sedum*; it may be formed by adding acid to the neutral salt; by exposure to heat it dries as a transparent varnish, which distinguishes it from other salts of lime and vegetable acids. It is soluble in water, but insoluble in alcohol. Malate of magnesia yields crystals which are unalterable in the air and are soluble in twenty-eight parts of water; with excess of acid, a gummy deliquescent saline mass is formed. Malate of baryta both neutral and acidulous, is soluble and gummy; an insoluble subsalt may also be formed. Malate of strontia is gummy and deliquescent, the acid salt is but slightly soluble, but more so in hot than in cold water; the hot solution deposits crystals on cooling. Of the metallic malates we shall state the properties of a few:—Zinc forms three different compounds with this acid: the neutral malate crystallises in short four-sided prisms; it is soluble in 55 parts of cold water; by boiling water it is decomposed into a supersalt which dissolves, and a subsalt which is precipitated; bimalate of zinc crystallises in large regular octohedrons; the submalate is an insoluble white powder. Malate of peroxide of iron is a reddish brown-coloured deliquescent mass soluble both in water and alcohol. Malate of copper, whether neutral or acidulous, dries so as to form a green varnish which is unalterable in the air. The malate of silver is a gummy mass, but the bimalate is a crystallisable salt, which readily separates as such from solution in water. Malate of lead is nearly insoluble in cold water, but dissolves in boiling water, and the solution on cooling deposits brilliant white crystalline scales of this salt.

Malic acid forms two amides, namely, *Malamic acid* ($C_8H_4O_7$, NH_2HO) isomeric with aspartic acid, and *malamide* ($C_8H_8N_2O_6$) isomeric with asparagin. [ASPARAGIN.]

The following compounds are closely related to these amides:

Phenyl-malamide or malanilide . . $C_8H_6(C_{12}H_5)N_2O_6$
Phenyl-malimide or malanile . . . $C_8H_4(C_{12}H_5)NO_6$
Phenyl-malamic acid or malanilic acid . $C_8H_6(C_{12}H_5)NO_8$

MALICIOUS INJURIES TO PROPERTY. At common law mischief perpetrated with whatever motive against the property of another was not punishable criminally, unless the act amounted to felony, or was accompanied with a breach of the peace, or affected the public convenience. In other cases the offender was liable only to an action for damages at the suit of the party injured. But the legislature has, at different times, interposed to repress, by penal enactments, injuries to private property of an aggravated nature, committed with the malicious intention of injuring the owner of such property. The different statutory provisions against mischievous acts done wilfully and maliciously were modified, as well as consolidated, by 7 & 8 Geo. IV., c. 30,* which also contains a provision rendering it immaterial whether the malice of the offender be against the owner of the property or otherwise.

By the third section of that statute it is made felony punishable by transportation for life or not less than seven years, or by imprisonment not exceeding four years, with or without whipping in the case of a male, to cut, break or destroy, or damage with intent to destroy or to render useless, any goods or articles of silk, woollen, or linen, or of articles in which any of those materials are mixed, or any frame-work-knitted piece, stocking, hose, or lace, in any stage of manufacture; to cut, break or destroy, or render useless warps or shoots of silk, woollen, linen or cotton, or of any of those materials mixed with each other or with any other material; or looms, frames, machines, engines, racks, tackles, or implements prepared for or employed in manufacturing or preparing such goods; or to enter by force into any place with intent to commit any of those offences. By section 4, it is made felony punishable by transportation for seven years, or imprisonment not exceeding two years, with or without whipping in case of a male, to cut, break or destroy, or damage with intent to destroy or render useless, threshing-machines, or machines or engines prepared for or employed in manufactures, except those manufactures, &c. injuries to which are more severely punishable under the 3rd section.

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* A bill has been introduced into Parliament, in the present session (1860), to consolidate the whole of the existing laws relating to malicious injuries to property.

By the 6th and 7th sections it is made felony punishable by transportation for seven years, or by imprisonment not exceeding two years, with or without whipping in the case of a male, to cause water to be conveyed into mines, or subterranean passages communicating therewith, or pull down, fill up, or obstruct air-ways, water-ways, drains, pits, levels, or shafts, with intent to destroy, damage, or hinder or delay the working of mines; or maliciously to pull down, or destroy, or damage with intent to destroy or render useless, steam-engines, or engines for making, draining, or working mines, or staiths, buildings, or erections used in conducting the business of mines or bridges, waggon-ways, or trunks for conveying minerals from mines, whether completed or unfinished. By sect. 12 it is made felony punishable by transportation for life or not less than seven years, or by imprisonment not exceeding four years, with or without whipping in the case of a male, to break down or cut down sea-banks or sea-walls, or the banks or walls of rivers, canals, or marshes, whereby lands are overflowed or damaged, or in danger of being so; to throw down, level, or destroy locks, sluices, floodgates, or works on navigable rivers or canals. And by the same section it is made felony punishable by transportation for seven years, or by imprisonment not exceeding two years, with or without whipping in the case of a male, to cut off, draw up, or remove piles, chalk, or other materials fixed in the ground and used for securing sea-banks or sea-walls, or the banks or walls of rivers, canals, or marshes, or to open or draw up flood-gates, or to do other injury or mischief to navigable rivers or canals, with intent or so as to obstruct or prevent the carrying on or completing or maintaining the navigation.

It is made felony, punishable by transportation for life, or not less than seven years, or by imprisonment not exceeding four years, with or without whipping in the case of a male, by the 13th section, to pull down or destroy public bridges, or to do any injury with intent or so as to render them dangerous or impassable; and by the 18th section, to cut or destroy hop-bines growing on poles in any hop-plantation. But now (by 7 Wm. IV. and 1 Vic., c. 90, s. 2) the punishment of the latter offence is made transportation not exceeding 15 years and not less than 10 years, or imprisonment not exceeding three. By 7 & 8 Geo. IV., c. 30, s. 14, it is a misdemeanor punishable accordingly [MISDEMEANOR] to throw down, level, or destroy turnpike-gates, or walls, chains, rails, posts, bars, or fences belonging to turnpike-gates set up to prevent passengers passing by without paying toll, or houses, buildings, or weighing-machines for the collection, ascertainment, or security of toll. The 15th section makes it a misdemeanor punishable by transportation for seven years, or by imprisonment not exceeding two years, with or without whipping in the case of a male, to break down or destroy dams of fish-ponds, or of water being private property, or in which is a private right of fishing, with intent to take or destroy fish, or so as thereby to cause the loss or destruction of fish, or to put lime or noxious materials in ponds with intent to destroy fish, or to break down or destroy dams of mill-ponds. By section 16 it is made felony to kill, maim, or wound cattle; but the punishment is reduced by 7 Will. IV. and 1 Vict., c. 90, s. 2, to transportation not exceeding 15 years and not less than 10, or to imprisonment not exceeding three. The provisions of this statute (7 & 8 Geo. IV., c. 30) relating to the destruction of trees, plants, &c. have been already noticed. [LARCENY.]

By section 17 it was made felony punishable by transportation for seven years, or by imprisonment not exceeding two, with or without whipping in the case of a male, to set fire to any crop of corn, grain, or pulse, whether standing or cut down, or to any part of a wood, coppice, or plantation, or to any heath, gorse, furze, or fern, and by 7 Wm. IV. and 1 Vict., c. 89, it is made felony punishable by transportation for life or not less than 15 years, or by imprisonment not exceeding three (sect. 10), to set fire to any stack of corn, grain, pulse, tares, straw, haulm, stubble, furze, heath, fern, hay, turf, peat, coals, charcoal, or any steer of wood, or (sect. 11) to set fire to any mine of coal or cannel coal.

The enactments in this statute with respect to the burning of houses, &c. [ARSON] have been repealed; and now by 7 Wm. IV. and 1 Vict., c. 89, s. 2, it is felony punishable by death to set fire to a dwelling-house, any person being therein; and by s. 3 it is felony punishable by transportation for life, or not less than 15 years, or by imprisonment not exceeding three, to set fire to a church or chapel, or a chapel for the religious worship of dissenters, or to a house, stable, coach-house, outhouse, warehouse, office, shop, mill, malthouse, hop-oast, barn, or granary, or to a building used in carrying on trade or manufacture, whether in the possession of the offender or of any other person, with intent to injure or defraud any person. By the 7 & 8 Vict., c. 62, the last-mentioned provisions were extended to the burning of farm buildings, and of farming produce therein; and by the 9 & 10 Vict., c. 25, s. 7, the attempting to set fire to any building, vessel, or mine, or to any stack or steer, or to any vegetable produce, of such kind, and with such intent that the offence, if complete, would be felony punishable by transportation for life, is also made a felony punishable by transportation not exceeding 15 years, or imprisonment not exceeding two years.

The stat. 14 & 15 Vict., c. 19, makes the setting fire to any station, engine-house, warehouse, or other building belonging to any railway, dock, canal, or other navigation, a felony punishable by transportation for life, or not less than seven years, or imprisonment not exceeding three years; and the same statute also makes the setting fire to goods or chattels in any building, the setting fire to which is felony, itself a felony, punishable by transportation not exceeding ten nor less than seven years, or imprisonment not exceeding three years.

For the protection of shipping against malicious mischief several statutory provisions have been made. By the 12 Geo. III., c. 24, the wilful and malicious burning or destroying of any of the king's ships of war, or arsenals, dockyards, victualling offices, or military, naval, or victualling stores, &c., is made a capital felony. By 1 & 2 Geo. IV., c. 75, s. 11, it is felony punishable by transportation for seven years, or imprisonment for any number of years, to cut away, cast adrift, alter, deface, sink, or destroy, or do any act with intent to cut away, cast adrift, remove, alter, deface, sink, or destroy, or injure or conceal buoys, buoy-ropes, or marks belonging to ships or vessels, whether in distress or otherwise. By 7 Geo. IV., c. 30, s. 10, it is made felony punishable by transportation for seven years, or by imprisonment not exceeding two, with or without whipping in the case of a male, to damage otherwise than by fire (which offence had been made capital by s. 9) ships or vessels complete or unfinished, with intent to destroy them or to render them useless.

By 7 Wm. IV. and 1 Vict., c. 89, s. 5, it is made felony punishable by death to exhibit false lights or signals with intent to bring any ship or vessel into danger, or to do any thing tending to the immediate loss or destruction of ships or vessels in distress. And by s. 6 it is made felony punishable by transportation for life, or not less than 15 years, or by imprisonment not exceeding three years, to set fire to, cast away, or destroy ships or vessels, with intent to prejudice owners or part-owners of vessels or goods, or underwriters on ships, goods, or freight. And by the 4th sect. it is made felony punishable by death, to set fire to, cast away, or destroy any ship or vessel, either with intent to murder any person, or whereby the life of any person shall be endangered.

It is to be observed, with reference to the punishment for these offences, that penal servitude has been substituted for transportation. Malicious injuries to works of art, &c., in any museum or repository, or to pictures, statues, monuments, or painted glass, in any church or chapel, is, by the 8 & 9 Vict., c. 44, a misdemeanor punishable by imprisonment not exceeding six months, and if a male by whipping; and by the 17 & 18 Vict., c. 33, this provision is extended to public statues within the metropolitan police district.

Besides the criminal responsibility thus created in respect of the acts of spoliation above enumerated, the legislature has given summary relief to persons whose property has been subject to petty but wilful aggressions. Under the 7 & 8 Geo. IV., c. 30, s. 24, persons wilfully or maliciously committing damage, injury, or spoil, to or upon real or personal property, for which no remedy or punishment is specially provided by that act, are, on conviction before a justice of the peace, to forfeit and pay such sum of money as shall appear to him a reasonable compensation for the damage, injury, or spoil committed, not exceeding 5*l.*, to be paid, in the case of private property, to the party aggrieved, except where such party is examined in proof of the offence; and in such cases, or in the case of property of a public nature, or wherein any public right is concerned, the money is to be applied towards the county-rate or borough-rate; and, if such sums of money together with costs (if ordered) are not paid either immediately or within such period as the justice may appoint, the justice may commit the offender to the common jail or house of correction, to be kept to hard labour for any term not exceeding two calendar months, unless such sum and costs be sooner paid. This enactment does not extend to any case where the party trespassing acted under a fair and reasonable supposition that he had a right to do the act complained of, or to any trespass, not being wilful and malicious, committed in hunting, fishing, or in the pursuit of game.

By the 28th section any person found committing any offence against this act, whether punishable upon indictment or upon summary conviction, may be immediately apprehended without a warrant, by any peace-officer, or the owner of the property injured, or his servant, or any person authorised by him, and forthwith taken before some neighbouring justice of the peace.

These summary proceedings before magistrates must be commenced within three calendar months from the commission of the offence.

The provisions of the law of France with respect to malicious injuries to property are to be found in the 3rd section of liv. iii. of the Code Pénal, entitled 'Destructions, Dégradations, Dommages.' Capital punishment is denounced only against those who set fire to buildings, ships, warehouses, wood-yards (chantiers), forests, underwoods, or crops growing or cut down, or to any combustible matter placed so as to communicate fire thereto. Minor offences in forests are provided for by titre 12 of the Code Forestier.

MALINGERING. [FEIGNED DISEASES.]

MALLEABILITY, a property by virtue of which certain bodies, especially some of the metals, are capable, although in very different degrees, of being beaten out under the hammer (*malleus*, Lat.), or laminated between rollers. The following table represents the order of malleability:—

Gold.
Silver.
Copper.
Platinum.
Palladium.
Aluminum.
Zinc.
Iron.
Tin.
Lead.
Cadmium.
Nickel.
Cobalt.

Gold is usually cited as an extreme case of malleability. It is beaten to the 290,000th part of an inch in thickness, and often much thinner than this, even to the 367,650th of an inch, or about 1200 times thinner than ordinary printing paper, and even this is not the limit of malleability, although there are practical difficulties in the way of further reduction. Comparing equal weights of gold and silver, it will be found that silver can be made to cover a larger surface than gold, so that silver is really more malleable than gold, although the leaf cannot be beaten out so thin. The metals lithium, potassium, and sodium, as well as frozen mercury, admit of being extended under the hammer.

In the production of sheet-metal, the hammer has been to a great extent superseded by rollers. Iron, steel, and copper, are best rolled red-hot; zinc is most malleable between 300° and 400°; most of the other metals and alloys are rolled in the cold state. The rolling-mill performs its work in a more uniform and gradual manner than the hammer, and at the same time developes to the utmost the hardness, tenacity, elasticity, and ductility of such metals and alloys as admit of being rolled. During the process, the condensation is such that brittleness would be produced unless the process of annealing were resorted to at intervals. In rolling the thinnest sheets of metal, a number of them are often sent through the rollers at the same time. In some cases, gold and silver leaf for example, the metals are rolled as thin as they will economically admit of, after which the hammer is resorted to. Leaf iron has been rolled into sheets, the 2500th of an inch in thickness, and a square inch of the leaf weighed only three-quarters of a grain.

The difference between malleability and ductility is noticed under DUCTILITY. In both processes the particles seem to glide along each other's surface, and "the external layers of the metals are retarded or kept back, as it were, in a wave, whilst the central stream or substance continues its course at a somewhat quicker rate. The necessity for annealing occurs, when the compression and sliding have arrived at the limit of cohesion; beyond this the parts would tear asunder, and produce such of the internal cracks and seams met with in sheet metal and wire, as are not due to original flaws and air-bubbles which have become proportionably elongated in the course of the manufacture of these materials." Holtzapffel's 'Mechanical Manipulation.'

MALT; MALTING. Malt is made from all kinds of grain and from rice, but in England almost always from barley, for the use of brewers and distillers. It consists of grain which has become sweet and more soluble in water from the conversion of its starch into sugar by artificial germination to a certain extent, after which the process is stopped by the application of heat. The barley is steeped in cold water for a period which (as regulated by law) must not be less than 40 hours; but beyond that period the steeping may be continued as long as is thought proper. Here it imbibes moisture, and increases in bulk; at the same time a quantity of carbonic acid is emitted, and a part of the substance of the barley is dissolved by the steep-water. The proportion of water imbibed depends partly upon the barley, and partly on the length of time that it is steeped. From the average of a good many trials, it appears that the medium increase is about 47 per cent. in weight, and 20 per cent. in bulk. The carbonic acid emitted while the barley is in the steep is inconsiderable; and it is probable, from the experiments of Saussure, that it owes its formation, at least in part, to the oxygen held in solution by the steep-water. The steep-water gradually acquires a yellow colour. The quantity of matter which it holds in solution varies from $\frac{1}{50}$th to $\frac{1}{100}$th of the weight of barley. This extractive matter is obviously derived from the husk of the barley, and is that substance to which the barley owes its colour. Accordingly grain becomes much paler by steeping.

After the grain has remained a sufficient time in the steep, the water is drained off, and the barley thrown out of the cistern upon the malt-floor, where it is formed into a heap called the *couch*, about 16 inches deep. In this situation it is allowed to remain about 26 hours. It is then turned by means of wooden shovels, and diminished a little in depth. This turning is repeated twice a day or oftener, and the grain is spread thinner and thinner, till at last its depth does not exceed a few inches. When placed in a couch, it begins gradually to absorb oxygen from the atmosphere, and to convert it into carbonic acid, at first very slowly, but afterwards more rapidly. The temperature, at first the same with that of the external air, begins slowly to increase; and in about 96 hours the grain is at an average about 10° hotter than the surrounding atmosphere. At this time the grain, which had become dry on the surface, becomes again so moist that it will wet the hand, and exhales at the same time an agreeable odour, not unlike that of apples. The appearance of this moisture is called *sweating*. A small portion of alcohol appears to be volatilised at this period. The great object of the maltster is to keep the temperature from becoming excessive, which is effected by frequent turning. The temperature which it is wished to preserve varies from 55° to 62°, according to the different modes of malting pursued.

At the time of the sweating, the roots of the grains begin to appear, at first like a small white prominence at the bottom of each seed, which soon divides itself into three rootlets, and increases in length with very great rapidity, unless checked by turning the malt. About a day after the sprouting of the roots, the rudiments of the future stem, called *acrospire*, may be seen to lengthen. It rises from the same extremity of the seed with the root, and advancing within the husk, at last issues from the opposite end; but the process of malting is stopped before it has made such progress. As the acrospire shoots along the grain, the appearance of the kernel, or mealy part of the corn, undergoes a considerable change. The glutinous and mucilaginous matter is taken up and removed, the colour becomes white, and the texture so loose that it crumbles to powder between the fingers. The object of malting is to produce this change: when it is accomplished, which takes place when the acrospire has come near to the end of the seed, the process is stopped by drying the malt upon the kiln. The temperature at first does not exceed 90°; but it is raised very slowly up to 140° or higher, according to circumstances. The malt is then cleared, to separate the rootlets, which are considered injurious.

Barley, by being converted into malt, generally increases two or three per cent. in bulk; and loses, at an average, about 20 per cent. in weight, of which 12 are ascribed to kiln-drying, and consist of water, which the barley would have lost had it been exposed to the same temperature: so that the real loss does not exceed 8 per cent. The roots appear, from the process, to be formed chiefly from the mucilaginous and glutinous parts of the kernel. The starch is not employed in their formation, but undergoes a change, intended, no doubt, to fit it for the future nourishment of the plumule. It acquires a sweetish taste, and the property of forming a transparent solution with hot water. In short, it approaches somewhat to the nature of sugar, and is probably the same with the sugar into which starch is converted by boiling it with diluted sulphuric acid.

The following are the results of Dr. Thomson's analysis of barley and the pale malt made from it:—

	Barley.	Malt.
Gluten	3	1
Sugar	4	16
Gum	5	14
Starch	88	69
	100	100

In brewing ale, porter, and table-beer, three different kinds of malt are employed, which are known as pale or amber malt, brown or blown malt, and roasted or black malt, sometimes called patent malt. The pale or amber malt yields the saccharine or fermentable extract; the brown malt is not fermentable, but is employed to impart flavour; and the roasted malt is employed, instead of burnt sugar, merely to give colouring matter to porter. In the brown and roasted malts the sugar appears to be entirely converted into gum and colouring and extractive matters; and hence they are incapable of undergoing fermentation. The brown malt is subjected to a higher temperature in drying than the pale malt, and by a still further exposure to heat in revolving cylinders or roasters it is converted into black or patent malt.

Most of the changes which have occurred in the malt trade have been due to the peculiar manner in which the product is subjected to duty. Mr. Tyzard introduced a new arrangement of malting apparatus in 1852; and Mr. Plomley, in 1858, devised a mode of making the heat act upon the surface of the malt as well as upon the bottom, in drying; but the foregoing details will suffice to show the general principle on which the operation is conducted. The excise duty has had the effect both of limiting the quantity made, and of checking any improvements in the making. The malt-duty began in England in 1697, in Scotland in 1713, and in Ireland in 1783. In the hundred years from 1716 to 1816 there was scarcely any increase in the quantity of malt made in England; the measure never departing far from 24 million bushels in a year. This stationary condition, at a time when population was steadily increasing, was attributed partly to an increase in the taste for tea and coffee, but chiefly to the effect of duty and restriction. This duty rose gradually from 6*d.* in 1702, to 4*s.* 6*d.* in 1804; it is now a fraction under 2*s.* 9*d.* Since 1830, the quantity paying duty has varied from about 30 to 40 million bushels. In 1859 it was 40,406,447, besides 546,743 bushels exempted from duty on various grounds. The price has varied from 2*s.* 6*d.* to 10*s.* 6*d.* per bushel, during a century and a half, the average being about 4*s.* 6*d.* The excise regulations were so very stringent in past years, that the maltsters scarcely knew in what manner to conduct their business. An act, passed to regulate the trade in 1827, contained no fewer than 83 clauses, many of which were difficult of interpretation; more than 100 penalties under it were enforced in three years, amounting to a sum of 13,500*l.* This was replaced by a better statute in 1830, with numerous but intelligible clauses relating to the gauging of cisterns, the wetting of the malt, the emptying of the cisterns, the gauging of the malt when in the kiln, &c. Another act was passed in 1847, still further to facilitate the operations of the maltster without lessening the duty. The Commissioners of Inland Revenue, in a report drawn up in 1857, stated that they were much puzzled by attempts at fraud made by some of the less scrupulous maltsters. One fraud consisted in compressing the grain in the couch, so as to lessen the measure by which the duty was charged. Another fraud was that of mixing raw grain with malt, roasting the two together, and selling the mixture to the brewers as malt. This last trick has been counteracted by an order, according to which grain is to be considered as still unmalted unless the plumule extends half the length of the grain; and by compelling brewers to crush their malt in a way which would not be applicable to unmalted grain.

MALTA, KNIGHTS OF. [HOSPITALLERS.]

MALVA SYLVESTRIS (Wild Mallow), an indigenous, perennial, herbaceous plant, of very frequent occurrence, possessed in every part of mucilaginous properties, and which may be employed for the same ends as other demulcent herbs. The flowers only are officinal in Britain: when fresh, they are violet-coloured, but by drying become blue, and also lose a large quantity of their watery constituents, for 100 parts of recent flowers dry into 11. They have no odour, but a mucilaginous herbaceous taste. They yield their colouring principle both to water and alcohol. The alcoholic tincture furnishes one of the most delicate of re-agents for testing the presence of acids or alkalies.

MAMELUKES, or MEMLOOKS, a name derived from an Arabic word signifying slaves, was that of a military body which for a long time ruled Egypt. The Memlooks were first instituted in the early part of the 13th century by Malek Salech, grandson of Safadeen, which Safadeen was the brother of the famous Salah Edeen, the Koord, the founder of the Eyoob dynasty of the sultans of Egypt, which succeeded the Fatemides. Malek Salech purchased many thousands of slaves, with which the markets of Asia were then glutted in consequence of the devastating wars of Gengis Khan. He chose chiefly young natives of the Caucasian regions, whom he trained to military exercises, and embodied into a corps of 12,000 men called Memlooks. This corps, by its discipline and distinct organisation, became formidable to its masters. In 1254 the Memlooks revolted and killed Tooran Shah, the last prince of the Eyoobite dynasty, and raised to the throne of Egypt El Moez Turkoman Memlook. El Moez was murdered in 1261 by another Memlook called Baybers, who founded the dynasty of the Baharites, which conquered Syria, took Damascus, and put an end to the domination of the Abbaside caliphs. In 1382 Doulet el Memlook el Borgéeh, a Circassian Memlook, overthrew the Baharite dynasty, and founded the dynasty of the Circassian Memlooks, which, after losing all the conquests of the Baharites in Asia by the hands of the Ottomans, continued to rule Egypt till 1517, when Selim I., sultan of the Ottomans, marched into Egypt, defeated the Memlooks near Heliopolis, took Cairo, and put to death Tomaun Bey, the last of the Circassian dynasty. Selim however maintained the Memlooks as a military aristocracy in Egypt. The Beys of the Memlook, twenty-four in number, continued to be the governors of as many districts, though subject to a pasha, appointed by the Porte, who resided at Cairo. The beys were elected by their own body. [EGYPT, *Modern History of*, in GEOG. DIV.] This aristocracy continued to rule almost independent of the Porte till Bonaparte's invasion, when the bulk of Memlook cavalry was destroyed in several brilliant but useless charges upon the French squares supported by artillery, at the battle of the Pyramids, in July, 1798. The remains of this once splendid body with their beys retreated into Upper Egypt. After the English and the Turks had reconquered Egypt in 1801, the Porte was no longer inclined to allow the Memlooks to retain their former authority, and the Capitan Pasha treacherously murdered several of the beys whom he had invited to a conference. At last, in March, 1811, Mehemet Ali, pasha of Egypt, by a similar contrivance, destroyed 450 of them, among whom were their chiefs, in the citadel of Cairo. [MEHEMET ALI, in BIOG. DIV.] About 1200 escaped into Dongola, but the victorious troops of the pasha pursued them, and they are now extinct as a body. The Memlooks were recruited entirely from Caucasian slaves. The office of bey was not hereditary, but elective among them. Their morals were very depraved: they were rapacious and merciless, and their extinction has been rather an advantage than a loss to humanity.

MANCI'PIUM, MANCIPA'TIO. The right apprehension of these terms is of some importance to those who study Roman authors. The following is the description of *Mancipatio* by Gaius (i. 119, &c.):—"Mancipatio is a kind of imaginary sale, and is a peculiar privilege of Roman citizens. It is effected in the following manner:—There must be present not fewer than five witnesses, Roman citizens, of full age, and also another person, of the same class and condition, to hold the brazen scales, who is called *libripens*. The person who receives *in mancipio*, taking hold of the thing, says, 'I affirm that this man is my property, according to Quirital Law, and I have purchased him with this money (æs) and these brazen scales.' He then strikes the scales with the piece of money, and gives it to him from whom he receives *in mancipio* as the price. In this manner both slaves and free persons are mancipated, as well as animals, which belong to the class of things *mancipii* or *mancipi*, such as oxen, horses, mules, asses; lands also (prædia), as well in the city as in the country, which are of the class *mancipi*, such as are the Italic lands, are mancipated in the same way. The mancipatio of lands differs from that of other things in this respect only, that persons, whether free or slaves, cannot be mancipated unless they are present, it being necessary that he who receives *in mancipio* should take hold of that which is given him *in mancipio*: whence in fact comes the term *mancipatio*, signifying that the thing is taken (capitur) by the hand (manu); but it is the practice to mancipate lands which are at a distance."

In this passage Gaius describes generally what "mancipatio" is, and, by implication, what things admit of "mancipatio," or, in other words, what things are "mancipi." He was led to these remarks by that part of the subject-matter of his text which treats of the rights of persons, or *status*; and he prefaces his description of "mancipatio" by stating that all children who are in the power of their parents, and the wife who is in that peculiar relation to her husband when she was said *in manu viri esse* [MARRIAGE], are things *mancipi*, and may be mancipated in the same way as slaves. [EMANCIPATION.]

All things, as objects of ownership, were either "res mancipi" or "res nec mancipi:" and there is, observes Gaius (ii. 18, &c.), "a great difference between things 'mancipi' and things 'nec mancipi.' The latter can be alienated by bare tradition or delivery, if they are things corporeal, and therefore susceptible of delivery. Thus the property in a garment, gold, or silver, may be transferred by bare tradition. Lands in the provinces may be transferred in the same way." Thus, "mancipatio" was the proper term for expressing the sale or transfer of things "mancipi;" and "traditio" for expressing the transfer of things "nec mancipi." (Ulpian, 'Frag.,' tit. 19.)

It appears then that the ownership of property generally which belonged to that class of things called "res mancipi" could only be transferred by the formalities already described: but that the ownership of things which were "res nec mancipi," and among them, lands in the provinces, could be transferred without the formalities required in the case of "res mancipi." The foundation of the distinction as to lands appears to be this. The real ownership (dominium) of provincial lands was either in the Roman people, in which case the lands were called Stipendiaria; or in the reigning Cæsar, in which case they were called Tributaria. There was therefore no ownership, properly so called, of lands in the provinces by individuals; at least no ownership in the sense in which lands in Italy were held. Lands in Italy held by individuals in full or Quiritarian ownership could be the subjects of usucapion, in jure cessio, mancipatio, and vindicatio; lands in the provinces could not, unless they acquired the Jus Italicum. Originally all the conquered lands even in Italy were Ager Publicus, the property of the state, and so long as they remained in that condition, nothing beyond the use (usus fructus) and occupation of them [POSSESSION] could be in private individuals. Much of the Ager Publicus in course of time was assigned to citizens in full ownership, and accordingly it would become "mancipi" and subject to the same rule as to alienation as other lands held in Quiritarian ownership.

Mancipatio could only take place between Roman citizens and Latini Colonarii and Latini Juniani, and those Peregrini who enjoyed the Commercium, or privilege of buying and selling. As the effect of Mancipatio was to transfer Quiritarian ownership with its accessory rights of usucapion, in jure cessio, mancipatio, and vindicatio, the reason of the rule is obvious. The form of mancipatio was in some respects a disadvantage, inasmuch as without observing the formalities required by the law, the *legal* property in a thing "mancipi" could not pass. The mancipatio was that form of transfer of which we find similar examples in the early history of most countries, and implied originally an actual seisin of the thing transferred. No writing being required, it was necessary that there should be some evidence of the transfer, and such evidence was secured by the mode of transfer which the law required. So far as relates to land, mancipatio in its origin may be presumed to have been equivalent to the feoffment with livery of seisin. [FEOFFMENT.]

There was another mode of alienating things "mancipi," by the form called *in jure cessio*, which, according to Ulpian, was applicable also to things "nec mancipi." The *in jure cessio* was a fictitious action before a competent magistrate at Rome, or a praetor, or before a praeses in a province. The purchaser claimed the thing as his, and the seller either acknowledged his claim or made no defence, upon which the magistrate gave judgment for the purchaser. This form was in effect and was called "legis actio." (Gaius, ii. 24.) Its great resemblance to the fictitious suit formerly in use in our own system, called a Fine, might lead to the the conjecture that the notion of a Fine was taken by the early practitioners in our courts from the Roman Law; and that this hypothesis is exceedingly probable will be the more apparent, the further any person examines into the connection between the early English and the Roman Law. The *in jure cessio* has apparently a closer resemblance to a Fine than the *transactio* of the Roman Law, to which some writers would refer as the origin of the Fine. (Spence's 'Court of Chancery,' vol. i., p. 142; citing Glanville, viii., c. 1, 2, 3.)

Mancipatio, as Gaius observes (ii. 26), was more in use than the *in jure cessio*, inasmuch as it was easier to transact the business with the assistance of a few friends then to go before a praetor, or a praeses.

Easements (*jura prædiorum*, otherwise called *servitutes*) could be transferred in the case of lands in the city only by the *cessio in jure;* but in the case of lands in the country, also by *mancipatio.* But this observation applies only to Italic lands; in the provinces, rights of this kind, such as right of road, of conveying water, &c., were matter of contract.

Some difficulty has arisen from the use of the word *nexum* or *nexus*, in connection with *mancipium.* "Nexum" properly signifies that which is bound or obligated, and hence it may signify the engagement or contract. Thus in the laws of the Twelve Tables, in the words, "quum nexum faciet mancipiumque," "nexum" may signify the contract. Cicero (*Topica*, 5) defines "Abalienatio" to be "ejus rei quæ mancipi est, aut traditio alteri nexu, aut in jure cessio, inter quos ea jure civili fieri possunt;" from which it follows that there are only two ways of transferring the ownership of things "mancipi," and as the *in jure cessio* is here mentioned as one, the *nexus* must represent the other, that is, the *mancipatio.* The "nexus" then in this case must be equivalent to the "mancipatio," or, as a more general term, must contain the mancipatio; for the mancipatio does not contain the nexum. This would be consistent with Varro (*De Ling. Lat.*, lib. 7,) quoting Mamilius, who says that everything is "nexum" which is transacted by the piece of money and scales (per æs et libram), which includes mancipium: but he adds that M. Scævola considered "nexum" to be everything transacted per æs et libram, so as to be thereby bound, *except* things which were transferred by mancipatio. Thus, the definition of Scævola would exclude "mancipatio" from the "nexum," but would include a testamentary disposition, inasmuch as that also was made per æs et libram (Gaius, ii., 103), and it would also include that form of marriage called *coemptio.* But if Scævola is right, and this can hardly be doubted, Cicero is wrong in the use of "nexum," in the passage quoted. In the "Orator" (i. 39) he mentions both "nexa" and "mancipia" in his enumeration of the various subjects brought before the Centumviri. Assuming Scævola's definition to be correct, Cicero may have properly distinguished "nexum" from "mancipium" in the passage in the "Orator;" and have used *nexu* with some inaccuracy in the passage from the "Topica."

Brissonius adopting Gronovius's explanation, maintains that the difference between the nexus and the mancipatio was not in the form or mode of transfer but in the effect; for whereas no transfer of the dominium or full ownership was necessary when the nexus was adopted, the mancipatio always conferred a Quiritarian dominium. ('Brisson sub voce Nexus.')

MANDA'MUS is a writ by which the court of queen's bench, in the name of the reigning sovereign, commands the party to whom it is addressed to do some act in the performance of which the prosecutor, or person who applies for or sues out the writ, has a legal interest; that is, not merely such an interest as would be recognised in a court of equity or in a court of ecclesiastical jurisdiction, but an interest cognisable in a court of common law; the right must also be one for the enforcing of which the prosecutor has no other specific legal remedy. Thus, a copyholder can transfer or alien his customary tenement or estate [Copyhold] in no other manner than by surrendering it into the hands of the lord of the manor to the use of the purchaser or surrenderee. The courts of common law formerly took no notice of the right of the surrenderee to call upon the lord for a grant or admittance, and the court of queen's bench therefore left the party to seek his remedy in a court of equity, and would not interfere by granting a mandamus. But the obligation on the part of the lord to admit the surrenderee is not merely an equitable liability, because this mode of transferring property of this nature is founded upon ancient custom, and rights dependent upon custom are matters of common-law cognisance. Of late years the court of queen's bench appears to have taken this view of the subject, and has awarded writs of mandamus in all cases where the lord has refused to admit the party to whose use a surrender of the copyhold has been made. Again, the duty of parishioners to assemble in vestry for parochial objects, whether those objects be of a temporal or spiritual nature, is a common law-duty, and a mandamus will be granted to compel the parishioners to meet. But when they are met, the power of the court to interfere further by mandamus depends upon the nature of the act which the parishioners have to do. If the provisions of a statute are to be carried into execution, the act to be done, whatever its nature, is considered a temporal matter, because the construction of statutes belongs preeminently to the courts of common law. But if the object for which the vestry are assembled be one purely of ecclesiastical cognisance, as the setting up of bells, the purchase of books or vestments necessary for divine service, or the making provision for the repairs of the fabric of the church (delinquencies in which matters are punishable by interdict [Interdict] and ecclesiastical censures), the court of queen's bench, being without judicial knowledge on such subjects, has no jurisdiction. It is probable indeed that ecclesiastical censures would formerly have been pronounced with less severity against the original delinquents than against those who should have attempted to bring such cases before a lay tribunal. Again, the court can by mandamus compel the visitor of an eleemosynary foundation to hear an appeal, but it has no further authority than "to put the visitorial power in motion." It cannot compel him to do any specific act as visitor.

The term "mandamus" (we command) is found in a great variety of writs, and those usually distinguished by this name by the old law writers are totally different from the modern writ of mandamus, which appears to be nothing more than the ancient "writ of restitution" enlarged to embrace a great variety of objects, that writ being adapted merely to the purpose of restoring a party to an office from which he has been unjustly removed.

The writ of mandamus is now granted not only to restore a man to an office from which he has been wrongfully removed, but also to admit to an office to which the party has been duly elected or appointed. It lies for a mayor, recorder, alderman, town-councillor, common-councilman, burgess, and town-clerk,—for a prebendary, master of a free-school, parish-clerk, sexton, and scavenger,—to hold a court-baron, court-leet, or a borough court of record,—to justices, to do an act within the scope of their authority, and which will not subject them to an action—to restore a graduate in a university to degrees from which he has been suspended,—to a corporation, to pay poors-rates where they have not sufficient distrainable property,—to parish officers, to receive a deserted infant,—to permit inspection of documents of a public nature in which the party is interested,—to appoint overseers of the poor,—to swear in churchwardens,—to proceed to the election of a corporate officer,—to grant probate or letters of administration,—to affix the common seal to an answer agreed to by the majority of the members of a corporation aggregate,—and to allow a poor-rate, in which case the rule for a mandamus is absolute in the first instance.

The mandamus is said to be a prerogative writ; by which is meant, —either that the power to award is not delegated by the crown to the ordinary judges between party and party, that is, the justices of the common pleas, but is reserved for that court in which the king is supposed to be personally present,—or that it is a writ of grace and favour granted according to discretion, and not a writ of right, that is, not such a writ as the party applying for it has a right to call upon the court to issue under the clause of Magna Charta, by which the king binds himself not to refuse or delay justice or right.

In order to obtain a mandamus the applicant lays before the court the affidavit of himself or others presenting the facts upon which his right and interest in the thing to be done, and his claim or title to the remedy, are founded. Upon this application the court, if it see a probable cause for interference, grants a rule calling upon the party against whom the writ is prayed, to show cause why such writ should not be awarded, or the court may grant a rule absolute in the first instance (17 & 18 Vict., c. 125, s. 76).

In the case of a mandamus to elect a corporate officer, if the applicant gives ten days notice of the application, with a statement of the grounds, and a copy of the affidavits, cause may be shown in the first instance. (6 & 7 Vict., c. 89, s. 5.) In other cases at the appointed time the party called upon either does not appear, in which case the rule is made absolute, and the mandamus is awarded as prayed, or he appears and resists the rule, either by insisting upon the insufficiency of the facts disclosed by the affidavits upon which the rule was obtained, or by producing other affidavits which give a different aspect to the transaction. If the resistance be effectual the rule is discharged; if not, the mandamus is awarded.

The writ, in the first instance, issues in an alternative form, requiring the party to do the act, or to show why he has not done it. The party may therefore make a return to the writ, saying that he has not done the act required for such and such reasons. Where the reasons returned are insufficient in law, the court quashes the return, and awards a peremptory mandamus requiring the party absolutely, and without allowing him any alternative, to do the act. Where the answer is apparently sufficient, the mandamus is at an end; and if the statements are untrue, the remedy is by action on the case for a false return, though in order to avoid expense and delay the party is allowed in some cases, by the statute 9 Anne, c. 20, and now in all cases, by 1 Will. IV., c. 21, to engraft an action upon the mandamus itself by traversing the return, namely, by putting in a plea contradicting the allegations contained in such return (Comyns's *Digest;* Selwyn's *Nisi Prius*); and the prosecutor may demur to the return, and a writ of error lies upon the judgment (6 & 7 Vict., c. 67).

Besides this prerogative writ of mandamus, the plaintiff in any action in the superior courts, except replevin and ejectment, may now indorse upon the writ and copy to be served, notice that he intends to claim a writ of mandamus, and the plaintiff may thereupon claim in the declaration, either together with any other demand which may be enforced in such action, or separately, a writ of mandamus, commanding the defendant to fulfil any duty in the fulfilment of which the plaintiff is personally interested. (Common Law Procedure Act, 1854; 17 & 18 Vict., c. 125, s. 68.) The Court of Queen's Bench has held that this provision is confined to those cases where a writ of mandamus might have been applied for. (*Benson* v. *Paull*, 2 Jur., N. S. 425.)

Besides these provisions facilitating the writ of mandamus, justices of the peace may now be called upon by a rule in the ordinary way, to perform their duties (11 & 12 Vict., c. 44, s. 5), and so may judges or officers of the County Court (19 & 20 Vict., c. 108, s. 43).

MANDARINS is the general name of the officers of state in China. They are chosen from the men of letters or scholars from every part of the empire, who, having obtained their degrees and passed their examination, have their names inscribed in a register kept by a court or board established for this purpose. When an office in the administration is vacant, the court presents to the emperor a list of those who stand foremost on the register, from among whom the monarch appoints one to fill up the vacancy. Sometimes when there are several candidates equally qualified they draw lots for the vacant office. In Duhalde's time there were 13,600 mandarins all over the empire, independent of the military mandarins, or superior officers of the army. The civil mandarins are divided into nine classes, the highest of which, called Choong-t'hang or Kō-laon, are ministers of state, counsellors of the emperor, or presidents of the supreme courts. The governors of provinces rank in the second class. The secretaries of the emperor belong to the third class; the governors of cities to the fourth class, and so on. Each order has its distinctive mark of dignity. All is gradation and strict subordination among them.

MANDATE, as one of the contracts of the Roman law, was constituted where one by special agreement, or by tacit assent, had undertaken to perform some act gratuitously for another. The obligations incumbent on the mandatary, and enforced against him by law, arose, not from his receiving a consideration for what he had undertaken to do, but from his leading the mandant to believe that he would perform it, and thus causing damage if he should neglect it. It is distinguished from *negotiorum gestio*, where the person performing the service undertakes it without authority from the person for whose behoof it is undertaken; and from *locatio-conductio*, where the service is remunerated. The characteristics of *mandatum* are briefly stated in Heineccius, 'Ad. Inst.,' tit. 27, and by Gaius, iii. 155, &c. In England, mandate in this simple sense is a department of the law of bailment. [Bailment.] In Scotland there is a wide departure from the old Roman meaning of the word, almost every instance where one person acts for another being referred to the contract of mandate; thus the commercial agent buying and selling, and the solicitor conducting a litigation, are said to be "mandatories." The case in which, by the practice of the law of Scotland, the word mandate in its old sense is best exemplified, is in trusts, which, instead of being subject to the complex legal peculiarities which characterise the system in England, are merely treated as simple mandates.

MANDELIC ACID. Synonymous with *Formobenzöilic acid.* [Formyl, *Formobenzöilic Acid.*]

MANDOLINE, a musical instrument of the lute kind, but smaller, having four strings, which are tuned as those of the violin. The mandoline is still met with occasionally in Italy, but has fallen into disuse in most other parts of Europe.

MANDORE, a musical instrument of four strings, of the lute kind, no longer in use under such name.

MANES, the name given by the Romans to souls separated from the body. According to Apuleius ('De Deo Socrat.'), they were originally called *lemures*, and were divided into two kinds, *lares* and *larvæ;* the former being the souls of such persons as had lived virtuous lives, and the latter of such as had been wicked, but afterwards the name of manes was applied to both. [Lares.] The etymology of manes is uncertain; it is generally derived, by ancient grammarians, from an old word, *manus*, signifying "good," probably in the same sense as the Furies were called Eumenides by the Greeks. Some considered the manes as the good and bad genii which accompanied a man through his life; but this notion appears to have been introduced by the later Platonists.

The stones in the Roman burial-places and their funeral urns were generally inscribed with the letters D. M. S.—that is, *Dis Manibus Sacrum,* "Sacred to the Manes Gods." There are many specimens of such funeral inscriptions in the British Museum. It was the duty of the Pontifex Maximus to see that the Manes were propitiated by proper ceremonies (Liv., i. 20); and with this object it was usual to pour libations of wine on the funeral piles, and also sometimes to slaughter animals, especially such as the deceased had been fond of. (Plin., 'Ep.,' iv. 2.) The 19th of February was dedicated as an annual festival to the Manes, under the title of Parentalia, or Feralia, when it was the special duty of children and heirs to offer sacrifices to the Manes of their ancestors. (Ovid, 'Fast.,' ii. 535; Virgil, 'Æn.,' ix. 258; Gaius, ii. 4.)

MANETTIA CORDIFO'LIA is a Brazilian twining plant, whose roots possess considerable emetic energy. The bark is administered in Brazil in powder, in doses of ½ to 1½ drachms, and is considered a most valuable remedy in dropsy and dysentery. (Lindley's *Flora Medica*, No. 862, p. 432; Maund's *Botanist*, vol. ii., pl. 87.)

MANGANATES. [Manganese; *Manganic Acid.*]

MANGANESE (Mn). This metal was not isolated till about the middle of the 18th century, the natural compounds containing it having been up to that time supposed to be ores of iron. It is a constituent of many minerals and, as black oxide, occurs frequently in abundance. The composition of its ores, and the localities whence they are derived, will be found described under Manganese, in Nat. Hist. Div.

Metallic manganese may be obtained, though with difficulty, by igniting carbonate of manganese made up into a paste with oil and sugar. For this purpose, a crucible should be lined with charcoal, the cover luted on, and the whole exposed to the heat of a smith's forge for a couple of hours. A button of metal is thus procured which may be purified by re-igniting in a crucible with a little more of the carbonate.

Manganese is a grayish white metal of inferior lustre, is hard enough to scratch steel, is very brittle, easily split, feebly magnetic, has a granular texture, and a specific gravity of 8·013. When pure, it speedily absorbs oxygen from the air, and is therefore most conveniently kept below the surface of naphtha. It appears to exist in two allotropic modifications, and combines with carbon and with silicon when fused in contact with those substances. In the finely divided state it slowly decomposes cold water; hot water being rapidly attacked by it, with liberation of hydrogen. Most acids act upon it energetically.

The equivalent of manganese is 27·57. Its specific gravity, 8·013.

Manganese and *oxygen* unite in seven different proportions; two of the resulting compounds are, however, usually considered to be mixtures of the other oxides. They are:—

1. Protoxide	MnO
2. Sesquioxide	Mn_2O_3
3. Binoxide	MnO_2
4. Red oxide (Hansmannite)	Mn_3O_4
5. Varvicite	Mn_4O_7
6. Manganic acid	MnO_3
7. Permanganic acid	Mn_2O_7

1. *Protoxide of manganese* (MnO). *Manganous oxide.* Obtained on heating carbonate of manganese in a current of hydrogen. It is a green coloured powder, and if prepared at a dull red heat, has such affinity for oxygen as to be spontaneously inflammable. It is a powerful base, and forms stable salts with the acids.

Hydrated protoxide is a white precipitate produced on adding an alkali to an aqueous solution of a manganous salt. In contact with air it rapidly absorbs oxygen and becomes brown.

2. *Sesquioxide of manganese* (Mn_2O_3) is formed when the protoxide is exposed to the air. It is a feeble base, isomorphous with alumina and sesquioxide of iron.

It occurs native as *braunite.* Its solution in dilute sulphuric acid is red, and on the addition of an alkaline sulphate, octohedral crystals are deposited, resembling alum, but having Mn_2O_3 in the place of Al_2O_3. The potash salt contains $Mn_2O_3, 3SO_3 + KO,SO_3 + 24Aq$.

Hydrated sesquioxide is produced by exposure of the hydrated protoxide to the air. It also occurs native. [Manganese, *Manganite*, in Nat. Hist. Div.]

3. *Binoxide of manganese* (MnO_2). *Peroxide of manganese.* This oxide occurs largely in nature, and is called *pyrolusite* by mineralogists, see Nat. Hist. Div. In commerce, it is generally simply termed *manganese*, and is largely used in the manufacture of chlorine compounds, also to give a black colour to earthenware, and in Glass Manufacture (vol. iv., col. 391).

When heated, binoxide of manganese yields up one-third of its oxygen; boiled with sulphuric acid it is converted into a salt of the protoxide, oxygen here also being eliminated.

The *assay of binoxide of manganese* is an important operation connected with the manufacture of bleaching-powder. It depends upon the conversion of oxalic acid into carbonic acid, by the action of the oxygen that is evolved when binoxide of manganese is heated with sulphuric acid. The apparatus in which it is performed is weighed before and after the evolution of the carbonic acid, and the loss sustained, that is the weight of the carbonic acid, exactly indicates the weight of peroxide of manganese in the sample.

4. *Red oxide of manganese* (Mn_3O_4, or $MnO + Mn_2O_3$, or $2MnO + MnO_2$) occurs native. [Manganese, *Hansmannite*, in Nat. Hist. Div.]

5. *Varvicite* (Mn_4O_7, or $Mn_2O_3 + 2MnO_2$). See also Manganese, in Nat. Hist. Div.

6. *Manganic acid* (MnO_3). Equal parts of caustic potash and binoxide of manganese are fused together, the mass being frequently stirred to promote absorption of oxygen. The resulting green mass is *manganate of potash.*

7. *Permanganic acid* (Mn_2O_7). *Hypermanganic acid.* When a strong solution of manganate of potash is poured into warm water, it immediately commences to pass through several successive changes of colour, and hence has received the name of *mineral chameleon.* The final colour is a purple, and is owing to *permanganate of potash.* The latter salt is however more quickly prepared by fusing binoxide of manganese with caustic alkali and a nitrate or chlorate.

The *permanganates* are far more stable salts than the *manganates*, and are mostly crystallisable. The potash salt occurs in beautiful prismatic crystals. Permanganic acid may be isolated, but not manganic acid.

The manganates and permanganates have of late years come into use as oxidising agents, especially for purposes of disinfection, as they readily yield up their oxygen to organic matter.

Manganese and *sulphur* form one compound, namely,—

Sulphide of manganese (MnS). *Manganous sulphide.* It occurs native as *manganese blende*, and is precipitated of a flesh colour when an alkaline sulphide is added to a solution of a manganous salt. It is soluble in acetic acid, a property taken advantage of in separating manganese from nickel and cobalt.

The *iodide, bromide,* and *fluoride of manganese* are unimportant salts.

Manganese and *chlorine* form—

Protochloride	$MnCl$
Sesquichloride	Mn_2Cl_3
? Perchloride	Mn_2Cl_7

Protochloride of manganese (MnCl) is the only important chloride. It is largely produced in the preparation of CHLORINE. By evaporation its solution yields pink crystals containing four equivalents of water of crystallisation.

Carbonate of manganese (MnO, CO_2) is a buff-coloured powder precipitated when an alkaline carbonate is added to a manganous salt.

Sulphate of manganese ($MnO, SO_3 + 7HO$, and sometimes $MnO, SO_3 + 5HO$). Formed by treating the binoxide with strong sulphuric acid. It is a rose-coloured soluble salt, isomorphous with sulphate of magnesia. It is largely used in dyeing and calico-printing. It forms *double salts* with alkaline sulphates.

Nitrate of manganese is a deliquescent salt occuring in acicular crystals.

Silicates of manganese. Several of these occur native. [MANGANESE, in NAT. HIST. DIV.]

Tests for manganese.—The non-precipitation by sulphuretted hydrogen, and the formation of the sulphide and hydrated oxide in the manner already indicated, readily characterise the protosalts of manganese. Manganese is also detected by the production of an amethystine bead when a very small quantity of the substance under examination is heated with borax in the blow-pipe flame.

Estimation of manganese.—Except for the valuation of the binoxide, this is usually effected by precipitating the carbonate and igniting it in an open crucible, whereby the red oxide (Mn_3O_4) is produced, containing 72·7 per cent of metal.

MANGANESE ALUM. [ALUMS.]

MANGANESE, *Medical Properties of.* During the prevalence of pneumatic medicine, preparations of manganese, particularly the binoxide, on account of the large quantity of oxygen it can yield, were much employed; but since the views of Beddoes and others, who recommended them, have become obsolete, the articles suggested to be used have fallen into oblivion. A rational ground for reviving some of them is to be found in the facts that oxide of manganese exists as a constituent of the bones, and may in some cases be deficient in these structures, and also that carbonate of manganese exists in some of the mineral springs of Carlsbad and Marienbad, and hydrochlorate of manganese exists in the waters of Kreutznach. The presence of these salts in waters much celebrated for their utility in various chronic diseases has suggested their employment in some of the complaints which are frequently benefited by them. But even if their curative properties are insufficient to establish them as valuable medicines, the deleterious effects of some forms of manganese justify a notice of them in this place. The extensive employment of black oxide of manganese in the preparation of bleaching-powder produces in some of the workmen a form of paralysis which should be early noticed, inasmuch as after it is thoroughly established it seems altogether incurable, and the only chance of escape is the complete abandoning of the occupation. It is limited to paralysis of the lower extremities, affecting the motor nerves only, for the sensibility is unimpaired. A staggering gait is the first symptom of its commencement: this is often perceived sooner by others than by the sufferer. No cholic, nor constipation, such as attends the use of lead, is manifested. (See Dr. Couper's paper in 'British Annals of Medicine,' i., p. 41.)

Binoxide of manganese has been used internally in pills, and also as a gargle; externally as an ointment in some obstinate cutaneous affections. It does not appear entitled to much attention. Hydrochlorate, and still more sulphate, of manganese, deserves attention as chologogue cathartics, or promoters of the secretion of bile. The latter salt has a cooling and bitter taste, resembling that of Glauber salts. Dissolved in a considerable quantity of water, and taken in the morning, it produces several liquid stools. Its purgative action may be increased by giving it with infusion of senna or with rhubarb. Alkalies and their carbonates are incompatible with it, as decomposition occurs. Its power of augmenting the secretion of bile renders it a valuable agent along with mercury, or as a substitute for it where mercury cannot be borne. It is useful in gout. Care must be observed in using it, as in doses as large as some writers have recommended, it causes dangerous, if not fatal, consequences.

The sulphated ferro-manganesian waters of Crausac, a village in the south-west of France, between Bordeaux and Toulouse, with springs in which this combination exists in two different degrees of strength, present a valuable means of benefiting feeble systems.

The manganate of potassa, known by the name of "mineral chameleon," furnishes a useful caustic and escharotic, especially for foul and fetid ulcers.

Manganic acid and permanganate of potass are very valuable disinfectants. Manganic acid is employed as a means of testing the purity or degrees of impurity of the air. [DISINFECTANTS.]

MANGANIC ACID. [MANGANESE.]

MANGE, an eruptive disease to which dogs, and all the canine race, as wolves, foxes, &c., as also horses, are subject. It usually occurs as the result of dirt and confinement, bad or deficient food, or some other circumstances producing a generally unhealthy condition. There are several forms of mange, but the red mange and the common scabby kind are the most frequent. It has many analogies to the itch in man [ITCH]; and the fluid discharged from the eruption of the mange in horses and dogs has sometimes been known to produce the itch in the human skin. Both appear to depend in general on the presence of a minute species of Acarus which burrows beneath the skin, and thus excites the irritation and itching by which these diseases are peculiarly characterised. The cure is to be effected chiefly by the use of preparations of sulphur, outwardly and inwardly; but the mange in dogs is usually difficult of cure.

MANGLE. [CALENDERING.]

MANGOLD WURZEL. For many years this plant has been increasing in agricultural importance. When well grown it is a much larger root than the Swedish or common turnip, and as it is cultivated more easily and with greater certainty, at the same time that it is, during most of the season, a better food, no wonder that its cultivation is increasing. It is more easy to get 30 tons of mangolds per acre than 20 tons of swedes; indeed, the latter crop is becoming more hazardous and unsatisfactory year by year, while every year mangolds are increasing in the estimation in which they are held. They are not liable to the attack of fly or caterpillar, and though a grub occasionally penetrates the leaf and eats out the substance of it, and though it is at midsummer sometimes attacked by a sort of canker, which appears to scorch the plant and check its further growth, yet it is much less liable to injury or disease than any other of our root crops; and sown as it is earlier in spring time than the turnip, it is sure of sufficient moisture during its early growth. In summer time it stands hot weather better than the turnip, and in the autumn it grows more rapidly to maturity. It needs to be harvested, pitted, or otherwise protected, before frost comes on, as it is not so hardy as the turnip, and this is the only point in which it is inferior. The cultivation of mangold wurzel very much resembles that of the turnip crop. It is usual to give it a heavier dressing of dung than the turnip receives, and this on heavy soils, which it rather affects, may well be put on in the autumn, thus leaving for spring time less occasion for anything beyond mere surface harrowing and stirring. The best way to prepare the land is, after a sufficient cleaning and stirring, to lay it up in ribs or drills at least 30 inches wide, to cart on 10 to 20 tons of farm-yard dung, per acre and cover it up before winter, by splitting the drills with the double mould-board plough. If this is not done till spring time, then before the dung is covered, it is well to sow broadcast whatever artificial manure is added; as, for instance, 3 cwts. of guano per acre, or 4 or 5 cwts. of a superphosphate, or blood manure. The splitting of the drills covers up this artificial dressing, at the same time that it gathers it somewhat together in the drill on which the seed is to be drilled or dibbled. Seven pounds of the seeds are needed per acre, and they may be soaked for a day or two in water before sowing, if it be desired to have an early braird. If drilled a row comes up along the top of each drill, and is afterwards singled out to intervals of 15 or 18 inches. If dibbled, three or four of the seed capsules are thrust into the soil with the half-closed hand, which holds them, so as not to place them deeply, and soil enough is laid upon them by a sliding half-pressure of the foot. The mangold seed is easily buried; half an inch of soil is more than covering enough. The seed thus comes up in bunches, the intervals between the rows are horse-hoed, and the intervals between the bunches are hand-hoed, and the bunches themselves are singled out by hand as soon as they are 2 or 3 inches high. Repeated horse-hoeings, and another hand-hoeing constitute the summer cultivation; and after a moist season, on good land well manured, a crop of 40 tons per acre is not an unusual produce. At the intervals of 30 inches and 18 inches respectively between the rows and the plants, about 11,000 plants may be expected per acre, or about 5 tons for every single pound the plants may average in weight; and 8 lbs. a piece is not an impossible average weight to attain.

Among the sorts are the red and yellow, and white, as to colour, and the globe, long, and bulged, as to shape.

The long red Elvetham which has a bulged shape is one of the best; the globe mangolds are probably the best for retaining their juice and freshness till a late period in the following year; for this is one principal advantage of this root, that it retains its value all through the summer, and is thus a most valuable food to keep for those awkward periods in a droughty season, which sometimes intervene between the successive forage crops on which the farmer depends for the continuous feeding of his stock. The mangold has hitherto been regarded as rather physic than food if taken early in the autumn; and there is an impression against it too as to its unfitness for breeding stock; there is also a feeling that it exhausts the land more than turnips for the ensuing grain crop.

On the first of these points we have now ample experience of its perfect safety however early it be given as food, the only thing needed as precaution being that it should be grated rather than cut in pieces, and mixed with chaff of straw and hay, rather than given whole, along with unchaffed fodder. The root-graters, which of late years have come into general use, are admirably adapted to this treatment of the mangold root, and any proportion between the succulent and the dry food may be thus adopted quite apart from any power of selection on the part of the animal thus fed, which may thus be provided with food just in the proportion needed to keep their fæces of the right consistence. This root, when thus gradually given to cattle, or sheep, or swine, may also be safely given to them when in breeding condition. It is a sudden change of food which is injurious to animals in that state, especially if it be from comparatively dry to succulent food. Mangolds are very succulent, but if animals are gradually accustomed to them, and at the same time drier food be mixed with them whenever the necessity is seen, no harm has been done by their free use for either sheep, pigs, or cows.

The impression that mangolds are an exhauster of the soil, has a real foundation in the fact that they generally produce twice as great a crop as swedes do; but probably the chief cause for the belief exists in the fact that swedes are generally consumed on the land by sheep, whereas mangolds, owing to their being less able (in fact unable) to withstand the frost, are more generally removed from the land and consumed in yards.

In order to protect this crop from the frost it must be lifted early in October, and carried to heaps either in sheds, or in pits on the ground and covered up with straw and earth. It is well to let them remain for a fortnight lightly covered with straw before covering them up with earth, as time is thus given for ventilation, and they dry a little, and are less liable to ferment and rot when in the closed heap. They may be gradually brought into consumption from early autumn, and given to all sorts of stock with perfect safety; but it is in late spring, and even through the summer, that their greatest value as feeding stuff is seen. When swedes and turnips get tough and pithy, they are still crisp and juicy, and increase in sweetness as they increase in age.

For small dairies the mangold is especially valuable, as during autumn a few of the lower leaves of the plant, still good as food, may be removed from it for that purpose and given to the cows. The mangold produces a poor milk, and a white butter, when given as the only food. This butter has a slightly bitter taste, but it has no such disagreeable taste as when derived from the consumption of turnips or cabbages.

MANGOSTIN ($C_{40}H_{22}O_{10}$?). A peculiar crystalline principle contained in the fruit of the *Garcinia mangostana*.

MANIA. [INSANITY: LUNACY.]

MANICHÆANS, [MANI, in BIOG. DIV.]

MANICHORD, a keyed musical instrument, of the spinnet kind, similar in all respects to the clavichord. [CLAVICHORD.]

MANIPULATION, CHEMICAL, the mechanical operations performed in the chemist's laboratory. For several such operations connected with chemical analysis, see CHEMICAL ANALYSIS; and for further details in that and other descriptions of chemical manipulation, see Faraday's 'Chemical Manipulations,' and 'Handbook of Chemical Manipulation' by Greville Williams, 1857.

MANNA, the concrete juice of the *Ornus Europæa*, and *Ornus Rotundifolia*, species of flowering ash which are natives of the South of Europe, growing abundantly in Sicily, Calabria, Apulia, &c. The juice exudes spontaneously in warm dry weather, and concretes upon the bark of the tree. It occasionally flows from the leaves, forming *tears*, now rarely met with in commerce. The flow is thought to be the result of the puncture of the *Cicada Orni*, Linn.; *Tettigonia Orni*, Fabric. It has a slight peculiar odour, and a sweetish taste, mixed with a slight degree of bitterness, and altogether leaves a disagreeable impression. Its texture is generally granular; but the finer pieces when broken are often hollow, and when examined by the microscope exhibit spicular crystals. Manna is perfectly soluble both in water and in alcohol; the crystals deposited by cooling a hot spirituous solution constitute a peculiar variety of sugar, which has been called *mannite;* it differs however from common sugar in not being fermentable. According to Bucholz, 100 parts of flake manna contain about 60 of mannite, mixed with uncrystallisable sugar, purgative principle, gum, &c.

Mannite is composed of—

	Prout.	Liebig.
Hydrogen	6·8	7·62
Carbon	38·7	40·02
Oxygen	54·5	52·35
	100·	99·99

Manna is employed as a gentle laxative, for children or persons of weak habits. It is however seldom exhibited alone, but as an adjunct to other more active medicines, as senna, rhubarb, &c. [FRAXINUS, MANNA, in NAT. HIST. DIV.]

MANNITE ($C_{12}H_{14}O_{12}$). *Mushroom Sugar, Grenadin, Fraxinin.* The juices of many plants contain a peculiar saccharine matter called mannite, which forms the principal constituent of the drug *manna*—the inspissated juice of the *fraxinus ornus*. Mannite is also found in celery, asparagus, onions, and several kinds of fungi. It is formed in large quantity in the process for preparing lactic acid, and finally it occurs in some descriptions of cider.

Mannite is most easily obtained in a state of purity by digesting manna in hot alcohol; on cooling the filtered solution, the mannite is deposited in crystals which fuse at 320°, are very soluble in water and possess a sweet taste. Mannite may be distinguished from cane sugar by forming *sulphomannitic acid* ($C_6H_7O_6$, $3\,SO_3$), without any charring when treated with sulphuric acid; from grape sugar it is also distinguished by not becoming brown when heated with solutions of the alkalies.

Mannite is not susceptible of alcoholic fermentation; nitric acid converts it into saccharic and oxalic acids, whilst a mixture of sulphuric and nitric acids transforms it into *nitromannite* $C_{12}H_8(NO_4)_6O_{12}$. Fused with hydrate of potash it gives a mixture of formiate, acetate, and propionate of potash:

$$\underbrace{C_{12}H_{14}O_{12}}_{\text{Mannite.}} = \underbrace{C_2H_2O_4}_{\text{Formic acid.}} + \underbrace{C_4H_4O_4}_{\text{Acetic acid.}} + \underbrace{C_6H_6O_4}_{\text{Propionic acid.}} + H_2$$

Heated with several of the acids mannite yields bodies resembling ethers, which under the influence of alkalies regenerate the original acid and a body named *mannitane* ($C_{12}H_{12}O_{10}$). The latter in contact with water gradually assimilates two atoms, and becomes reconverted into mannite.

Dulcose or *Dulcin* ($C_{12}H_{14}O_{12}$) and *Phycite* ($C_{12}H_{14}O_{12}$) are saccharine substances isomeric with mannite. *Quercite* ($C_{12}H_{12}O_{10}$) is also closely allied with mannite, and like the latter is converted into a detonating compound, *nitroquercite*, when treated with a mixture of nitric and sulphuric acids.

MANNITANE. [MANNITE.]

MANŒUVRES, or MILITARY EVOLUTIONS, are the movements made by any body of troops, either acting by itself or in conjunction with other bodies, for the purpose of arriving at or of retiring from a field of battle, or of placing itself in a position to act offensively or defensively against an enemy.

The circumstances attending the great movements of armies along their lines of communication, and the dispositions of the troops on the field of battle, are developed under the words STRATEGY and TACTICS. The present article will therefore comprehend merely a description of the manner in which the principal evolutions of a battalion of infantry, a regiment of cavalry, and an entire army, are performed, and will conclude with a short account of the movements of light troops in the field.

Evolutions of a Battalion.—When a battalion formed in line has to march in that order towards the front or rear, in order to ensure exactness in the movement, the centre serjeant, who is between the two colours, selects two points to march on under the superintendence of a mounted officer. When the line of direction is determined on, he gives the word "steady;" and on the word "quick march" being given, the battalion moves off, dressing by this serjeant, who moves straight to his front in this direction. To see that the centre serjeant preserves his direction correctly, the serjeant-major and a mounted officer remain halted until the line has advanced 20 or 30 paces; they then follow in rear. In the same way, when retiring, on the battalion facing about, the serjeant-major and a mounted officer pass through the ranks and place themselves behind the centre to superintend the movement, While the battalion is thus moving in line, the two flanked companies may be wheeled backwards, and made to march in files perpendicularly to the line of the battalion, in order to cover it; and on a halt being ordered, they would face towards the enemy.

This order of march can of course only take place where the country is open; when partial obstacles occur, the troops near them necessarily form in file till they have passed them, and afterwards they move up into the line, or the companies may advance by files or fours from the right or left; but when the obstacles are of great extent, and occur frequently, it is evident that the march of the battalion should be in column.

Columns formed for this purpose are designated columns of companies, of subdivisions, and of sections, according as their breadths, or the extent of their front, is equal to that of a whole, a half, or any portion of a company; and they are said to be at open order, at half, or at quarter distance, according as the intervals between the companies or their divisions are equal to the whole, to one-half, or to one-quarter of the breadth of the column. The order is said to be close when the several divisions are at the distance of one pace only from each other in the length of the column. When the company or subdivision whose position is on the right of the line is in front, the left of that company or subdivision is called the pivot, and the right the reverse flank, and *vice versâ*; that is, *when the right is in front the left is the pivot, when the left is in front the right is the pivot*, because, in reforming line, the wheel, except in wheeling backwards, must evidently be on this flank; for if the wheel were made on the other flank, the companies would become inverted.

The wheel from line into column, and the converse, when the battalion is at a halt, must obviously be performed by causing the divisions to describe a quarter of a circle on their respective pivots. But when a battalion in column is on the march, and it is required to change the route, should the divisions be at the full distances from each other,—that is, at intervals equal to the length of a division,—it is necessary that the first division, after having described on its pivot an angle equal to that which the new direction is to make with the former, should march forward as soon as the wheeling pivot of the next division has arrived at the like pivot of the first division; the second division then wheels and marches in like manner, and so on. The same rule may be followed when the divisions are at less than full distance, provided the angle which the intended direction of march makes with the former is sufficiently obtuse to allow the divisions to describe the required angle without interfering with one another, otherwise the wheeling is performed in this way: the leading company wheels round at a short pace, so regulated as to give time for the remaining companies to circle round the flank on which the wheel is being made. This is done by the rear companies, when at the halt, making a half-face to the right, or on the march a half-turn to the right (supposing the wheel to be to the left), and each man moving round on the circumference of a circle of which the wheeling-point is the centre. The wheelings may be made upon either extremity of a company or subdivision, and they may take place either forward or backward, according to circumstances; occasionally, also, a company is required to perform a wheel upon its centre, in which case one-half wheels backward and the other half forward; but in all cases the pivot-flanks are to remain dressed, or in one line.

When a battalion is formed into a column for the purpose of an attack, it is called a column of manœuvre; and when so formed in order to move along a road or through a defile, a column of route. In either case the column may be in open order, at half or at quarter distance, or in close order; and in the first formation the column, of course, occupies in length an extent of ground equal to that which it occupies in line, minus the length of the first division. Columns at half or at quarter distance, or at close order, have the convenience of moving upon less space than the open column, with equal capacity of forming in any manner that may be required for resisting an attack; and their compact order enables them to avoid the evils attending the loss of distances which may occur with an open column, from the inequalities of the ground.

The battalion in line may be formed into a single or double column: the former upon or in rear of either flank company, and the latter upon the two centre companies or the two centre subdivisions. In either case the column is equally fit for its purpose, and the preference of one to the other must depend upon the ground or upon the point to which the movement is to be directed: the single column, however, can always be diminished to the smallest degree, according to the defile; whereas the double column, if much diminished, may be in danger of becoming disordered by the intermixture of the files. For an attack, the column formed on the centre of a battalion can be more rapidly brought to bear upon the required point than a column formed on one of the wings, seeing that the divisions in line have but half the distance to march through in order to arrive at their places in the column, and a corresponding advantage is enjoyed when the battalion has to deploy from column into line.

It is to be observed that the front of a column should never be unnecessarily contracted, and battalions should be so instructed as to render it indifferent whether the first or second rank is in front, or whether the right or left flank division (of the line) is at the head of the column; but occasions may occur in which the order of battle is to be reversed, and then the divisions must necessarily change their positions by countermarching.

A battalion in column at open order is formed in line to the front by the rear companies wheeling backwards an eighth of a circle on their right or left, according as the right or left is in front, and then moving up in this direction the inward flank comes up to the alignement or flank of the halted company, then wheeling an eighth of a circle to the left or right, brings them up into line—or if the line is to be formed to a flank by merely causing the divisions to wheel upon their respective pivots; but a close column of companies, having its head already in the alignement, is *deployed* by causing the several divisions to move out by files to the right or left parallel to the alignement; each division having got beyond that which was in front of it turns to the left or right, and then marches up to its place in the line. The deployment may take place upon any one of the companies; should it be on one of the rear companies, it has to remain halted till its front is clear, when it moves up at a double—the other companies halting in the same way till their front is clear, and then moving up.

Echellon movements are performed when it is required to advance or retreat obliquely, and when a change is to be made in the position of a line, corresponding to a wheel of the whole about some given point: the movements are made to the front when an enemy's flank is to be turned, and to the rear when it is required to cover the flank of the line itself. Echellon movements are the safest that can be adopted by troops in presence of the enemy, as they have the advantage of preserving a general front during the march. A direct echellon, as it is called, may be formed by the different companies or subdivisions marching from their position in the line towards the front or rear, keeping parallel to that position, and halting successively when arrived at the required distances. The oblique echellon is formed by causing the different companies or subdivisions to make a wheel upon their pivots through any angle less than a right angle, but generally not more than one-eighth of it; the position and parallelism of the divisions being ensured by causing a non-commissioned officer of each division to place himself, as the case may require, before or behind the eighth file from the pivot, then by his taking paces of 30 inches (the regulation pace) on the arc of a circle, of which the pivot is the centre, he may indicate an alignement of any portion of the circle $\frac{1}{16}$, $\frac{1}{8}$, $\frac{3}{16}$, or $\frac{1}{4}$, that may be required, every 2 paces giving $\frac{1}{16}$ of the circle; the division is then to wheel up to the place where he halts.

An important evolution of a battalion is that of placing itself in a square or oblong form, with the men on the four sides facing outwards, so as to be enabled to resist an enemy who may attempt to surround them. This figure is generally formed hollow, or so as to inclose a space in which are the officers, or in which baggage or treasure may be placed for security; if otherwise, it is evident that great numbers of the men would be useless, since they could not use their fire-arms.

When a battalion in open column forms square on the leading company, the leading company, if moving, halts—the second company closes up to it and halts, the remaining companies, except the two last, wheel outwards by sections successively on coming up to quarter distance from those that precede them, the flank sections halting when they have wheeled the quarter circle, the others closing up to them. The two rear companies closing up and being faced about form the rear of the square.

When a battalion in line is to form a hollow square, the manœuvre may take place upon any given company, generally the left centre company, or upon one formed of the two contiguous subdivisions of two companies, which then for the moment remain at rest; while the other companies break out of the line and march to the rear of the troops who are stationary. The second division in the column marches close in rear of the first, and these two form the front of the square; the remaining companies march by fours, so as to form a column of companies at quarter distance in rear of these, when all, except the two last, wheel by sections outwards, as in forming square from column, and form the sides of the square: the last closes up to the next to it, and these two form the rear of the square. If the square is to resist an attack of cavalry, the two front ranks kneel and slope their firelocks outwards till, at the word of command, they fire a volley: the men in the two standing ranks fire by files, or independently of one another. In England, when the 2 rank formation is employed, the square will be four ranks deep, but with continental nations, where the 3 rank formation is employed, it would be six ranks deep; for instance, Bonaparte, while in Egypt, formed his infantry in squares whose sides were six ranks deep, in order to resist the Mameluke cavalry, while at Waterloo the English squares were four deep.

When several battalions form themselves into squares, they dispose themselves either en echellon or in two lines, each square in the first line being at some distance in front of the interval between two squares in the second line; by which means the fire of one square may defend the face of another.

Squares may be reduced to columns, and these to line, by reversing the processes above mentioned. One square consisting of several battalions is not recommended, as much time would be spent in its formation, and the safety of the troops might be endangered should they be attacked while so occupied.

A battalion in column may be obliged to engage in a street or narrow pass where deployment is impossible. In this case, if the column is advancing, the two front companies or divisions fire, the first kneeling and the other standing; after which, on a favourable occasion presenting itself, the whole column moves forward: if the column is to retire, the first division, after firing, faces outwards, half to the right and half to the left; these subdivisions file away to the rear, where they re-load; the second division fires, then files to the rear in like manner, and so on.

Evolutions of a Regiment of Cavalry.—The movements of cavalry on a field of battle, like those of infantry, consist of marches to the front or rear, in line or en echellon; deploying from open or close columns into line, and the converse.

If it be required to form a line for attack from an open column of divisions upon any particular division, those divisions which are in front go about by threes and make a wheel forward on the outward flank equal to one-eighth of a circle, and those which are in the rear wheel forward one-eighth; all the divisions being thus parallel to each other, they march in this order up to the alignement on the division which remained stationary, wheeling into it as they arrive. On the contrary, if the column be in retreat, and it be required to form a line on the defensive from an open column of divisions, suppose on the first division of the first or leading squadron, the leading squadron countermarches and all the remaining divisions make a wheel equal to one-eighth of a circle, and in this order march up and wheel into the alignement. It must be observed that the line first formed in these cases is to be at the distance of two horses' length in rear of the intended alignement, in order to allow the officers in front of each squadron to dress the troops, which they can do more correctly than the officers of divisions who are in the line itself.

To deploy in line to the front from a close column of squadrons for an attack, suppose on the second squadron; all the squadrons except this break into divisions by threes, as it is called (that is into divisions consisting of three horses in each of the two lines); the divisions of the first squadron wheel a quarter circle to the right, and march in that order till they get beyond the squadron on which the line is to be formed; the third and fourth squadrons also break into divisions in like manner, wheeling to the left, and marching till they get opposite their respective places in the intended line, which is supposed to be in front of the ground occupied by the first squadron, and into this line all the squadrons now march. But if the line be required to be formed on the rear of the regiment when in retreat, for the purpose of defence, suppose on the fourth squadron, this squadron must then change its front by a counter-march, the others break into divisions, wheel a quarter circle, and march to the left till they come opposite their proper places in the intended alignement, into which they then march as before.

The evolutions are made as above stated when the regiment is in column with its right in front; but it is easy to apply the precepts to the contrary case.

The reason why the squadrons are made to break into divisions by threes is that, since the breadth of three horses is about equal to the length of one, each division of three can wheel within a space equal to that which it occupies in line: the practice however has been objected to on account of the extension of the files which is produced when marching in this order. Movements by the usual divisions or sub-divisions have been preferred on this account, but the former method prevails.

Evolutions of an Army.—The general principles upon which the evolutions of armies, divisions, or brigades are performed, correspond nearly to those of single battalions. When a whole line has to advance parallel to itself, one of the battalions is considered as the regulator, and all the others should conform to its movements. The commander of this battalion must therefore devote his whole attention to the preservation of the direction which has been indicated by the general commanding the army, while the flank officers of the other battalions must endeavour to preserve the regularity of their own battalions by the line of the colours.

Columns of route or manœuvre are formed of any number of battalions, each in column of companies or of sub-divisions, in rear of one another: it is then termed a mass of columns; and if the columns are at close order, the interval between every two battalions is only six paces, or the same as if all the troops were drawn up in line. If the distances of the companies are equal to one quarter of the length of their front, the intervals between the battalions are twelve paces; but when the columns are at open order, the intervals of the battalions should be equal to the breadth of the column, together with the six paces which should be the intervals between the battalions in line. Such columns as the last can instantly be thrown into line to a flank by each company making simply a wheel on its proper pivot. When a mass of columns is required to form into what is called a line of columns, the heads of all the columns must be placed in one alignement, but the distances of the several columns from one another in the direction of the line may, according to circumstances, be of any extent, from six paces (in which case the columns are said to be contiguous), to the proper distance for deployment, that is, a distance equal to the length of a column.

A column whose divisions are either at quarter distance from each other, or in close order, can always wheel into a line of columns, because each battalion, in performing the wheel, leaves room for the wheel of that which is in its rear; but a line of contiguous columns, when the depth of each battalion exceeds the extent of its front, cannot for want of room be wheeled into a single column. When such a manœuvre becomes necessary, the line of columns must open out to the right or left far enough to allow the wheel to be performed. When a line of columns is required to be changed into one column, for the purpose of performing a march towards either flank, the most convenient disposition would be that in which all the columns in the line stand with their right wings in front, if it is intended that the march should be towards the right; and the contrary, if it is to be towards the left, for then a simple wheel to the front brings the divisions into the alignement in their proper order.

When a column is on a march, the baggage should be in the rear; or if, on any account, it is placed within the line, it should be, together with the artillery which accompanies the column, in the intervals between brigades, and never between the battalions of a brigade. The preservation of the original extent of a column in front is of importance, and defiling, in order to pass an obstacle, should be avoided if possible, on account of the loss of time which it occasions; in fact, it will frequently happen that, on arriving at a stream, a ditch, or a bank, the obstacle will be more conveniently passed by extending than by contracting the front.

Echellon movements of an army are almost always those which are made when in presence of the enemy, the inequalities of ground generally preventing large bodies of troops, if it were otherwise advisable to do so, from acting against one another in continuous lines. Like the echellon movements of battalions, those of an army may be either direct or oblique: the former are executed by advancing brigades, battalions, or companies parallel to and at unequal distances from their front; and this advance may be made from the centre of the line when it is intended to refuse both wings to an enemy, or from one flank when it is intended to turn that of the enemy. The direct echellon may also be produced by posting columns in proper situations, ready for deployment, parallel to the enemy's position: the distances between the battalions in echellon should be sufficient to allow them to form squares chequerwise, so as to flank one another.

Oblique echellons of an army are formed by wheeling, and then marching in the new directions so as to gain ground obliquely towards a flank; each of the several bodies performing the manœuvre should not exceed a company, as it might be hazardous to present one flank of a large body towards an enemy in position, and thus expose the line to be enfiladed. And, as the enemy would endeavour to counteract the intended project of outflanking him, should he observe it, advantage ought to be taken of the localities to conceal some of the divisions, and to gain points of support for the bodies placed in advance of the rest of the army. When it is intended to refuse one wing, the battalions of that wing may retreat *en echellon* as far as necessary, and the artillery of that part of the line which is stationary should be ready to enfilade the enemy on his advance towards the retiring divisions. Movements of attack may be made in columns, which should deploy in line at from 1200 to 1400 paces from the enemy; the destructive effects of an enfilading fire preventing a nearer approach in column.

Generally speaking, the most convenient order for an army, whether on the offensive or defensive, is in column, provided the columns can be covered by the ground from the enemy's artillery; since it may be readily moved up to any given point of attack, while the enemy has few means of judging where that point of attack will be.

Changes in the front of a position, when under fire, are best effected by an echellon march of companies; but when the line is extensive, the battalions which are most remote from the new alignement, and which may be attacked by cavalry during the movement, should be marched up in columns of battalions, the divisions being at quarter distances from one another.

The retreat of a line is accomplished by causing each alternate battalion to retire, perpendicularly to the front, to a certain distance towards the rear, not exceeding 200 yards, that the divisions may be able to support each other by their fires; the remaining battalions protecting the retreat of the others, and then retiring as far as the intervals between the former battalions, who then retreat still further, and so on. The intervals in the lines should be occupied by light infantry; and if the enemy should press closely, the second line of the army, after the first battalions have passed through it, must contribute by its fire to the defence of the intervals in the first line.

This retreat by alternate battalions, or by half-battalions, is indispensable when it is made over a plain; and if the retreat is to be continued, defiles and commanding spots of ground must be occupied and defended as long as possible; by degrees the bodies may diminish their fronts and form themselves into columns of march.

If a gradual retreat of the whole line is not intended, on a flank of the army being attacked, that flank only may be retired in direct echellon by alternate battalions or half-battalions, beginning with that which is at the extremity of the flank attacked; the remaining battalions then retire, still *en echellon*, thus keeping the menaced flank refused to the enemy, taking care that the distances between the corps are not so great as to render it impossible for them to defend each other by their fire. Each body must repel an attack, if made upon it by infantry, by a counter-attack; if by cavalry, it may dispose itself in a square; or a new line may be formed in the oblique position, if it be thought best thus to resist a general attack of the enemy.

The movements of the second line of an army should correspond exactly to those of the first, the two lines always preserving their parallelism and distance. The second is however frequently kept in a line of columns of battalions, and is made to move in that order even when the first line is deployed.

The most proper stations for cavalry are on the wings of an army, because troops of this class are unfit for resisting an attack; and should they be compelled to retire when placed in the centre, there would be left an interval which the enemy might immediately occupy, and from thence enfilade the wings. This false disposition was made by the French at the battles of Hochstet and Minden, and was the cause of their defeat in those actions. Cavalry are generally employed in the operation of turning a line; and it is evident that this manœuvre must be more readily made from the nearest wing than from the centre.

Manœuvres of Light Troops.—To the light infantry and riflemen, or troops acting as such, are entrusted the guard of the encampments or cantonments. When an army is on the march they reconnoitre the country, repel any parties of the enemy which might get between the columns while advancing; and they check the pursuit of the enemy in a retreat.

When a battalion is employed as light infantry, not more than one-third of the men should actually engage as skirmishers; these extend themselves in line, in two ranks, to the right and left, from some given file, at any distance which may be appointed; or, if no order is given, at the regulated distance of six paces. The rest of the battalion is divided into parties, as supports and as reserve, the supports, of which one party is usually in rear of the centre, and another is towards each flank, should be equal in strength to the skirmishers, and when the skirmishers have advanced about 200 paces to the front, these supports follow them, and are themselves followed by the reserve, at about 300 yards, the main body being about 500 yards behind. Each of the supporting bodies and the reserve should be kept in compact order; and when the skirmishers retire upon their support, they form in sections in its rear. The skirmishers advance or retire, as the case may be, in one general line, and they should avoid standing exposed if any cover, as that of a hedge, ditch, or copse, can be obtained on the ground: for this reason, when obliged to cross an open plain, their line should make a simultaneous rush towards the spots where they may fire under cover. On open ground, they fire kneeling or lying down, the front rank man discharging his piece first, then retiring in rear of the second rank and loading: as soon as he has loaded he gives the word, ready, in a low voice, when the second rank man fires and loads, care being taken that the muskets of both ranks are not unloaded at the same time.

On the appearance of cavalry the nearest supporters and the reserve move towards the threatened part, and form squares; the skirmishers at the same time run to any cover from whence they may aid the supports by a cross fire; or run in behind the supports, and form square under the protection of their fire; or if too suddenly attacked for this, form small knots or rallying squares, by running together at convenient points round their officers.

When light troops have to advance across a bridge, or through a short defile, on arriving at the bank of the river, or at the entrance of the defile, the skirmishers lie down in line and fire; the supports, strengthened by the reserve, charge the enemy on the bridge, or in the defile, drive him back, and then form an extended line as skirmishers, while the former skirmishers pass the bridge or defile, and now constitute the supports and reserve. In retreating the supports pass first over the bridge or through the defile, covered by the skirmishers and immediately deploy, in order to act as skirmishers themselves; the former skirmishers then rapidly pass, followed by the supports, and the whole form in column in rear of the present skirmishers, who then, by their fire, protect the retreat if it is to be continued.

MANO'METER (from two Greek words—*μανός*, thin or rare, and *μέτρον*, a measure) is the name given to instruments which measure the rarity of the atmosphere or other gas. As however the rarity of a gas is proportional to its elastic force, so long as its temperature and chemical composition remain unchanged, such instruments as measure the elastic force of gases are also, with this restriction, properly termed *manometers*, and accordingly it is to the latter instruments that the term is most frequently applied, both in this country and upon the Continent.

The "statical barometer" of Robert Boyle was a manometer of the simplest kind, consisting of an exhausted glass globe suspended from one extremity of a delicate balance, and counterpoised by a metallic weight at the other extremity, the adjustment being made when the atmosphere was in its mean state of density. Any subsequent variation in the specific gravity of the air would, by a known law of hydrostatics, destroy the equilibrium, and the motion of the globe would indicate whether the variation had inclined towards an increase or diminution of density, as in the former case it would ascend, in the latter it would descend.

Captain Phipps, in his north-polar voyage, and Colonel Roy, in order to correct his barometric observations, employed manometers, which gave the elastic tension of the atmosphere. They consisted of glass tubes similar in form to thermometer-tubes, and of various sizes. Those of Colonel Roy were from 4 to 8 feet in length, with bores from $\frac{1}{11}$th to $\frac{1}{27}$th of an inch in diameter. The bulb and part of the tube being filled with air of known tension, and the remainder of the tube being partially occupied by a small column of mercury sufficient to cut off the communication between the internal and external air; any variation in the elastic tension of the latter, arising from change of weight, would be accurately measured by the ascent or descent of the mercurial column; for whenever the tension of the atmosphere exceeded that of the contained air, the column would move towards the bulb, and the contrary. But if the change in the tension of the atmosphere were partly attributable to a change of temperature, then the motion of the column would merely measure the difference of the variations in the tension of the internal and external air, because the tension of both would be equally affected by the change of temperature. The bulb was pear-shaped, so that the "point being occasionally opened, dry or moist air could be readily admitted, and the bulb sealed again without any sensible alteration in its capacity." ('Phil. Trans.,' vol. lxvii., p. 689.) The manometers of Varignon and Wolf were similar to the preceding.

A more convenient instrument, and one of more general use, consists of a siphon-barometer, the basin of which is enclosed air-tight in a globular or other conveniently shaped vessel, furnished with a number of cocks, by means of which and the pneumatic pump the contained gas may be removed, and other gases successively substituted in its place. If equal parts by weight of different gases be thus successively introduced, they will not be affected by any change which may take place in the surrounding atmosphere, except in so far as such change may affect their temperature; so that, providing the temperature remain constant, the relative tensions of these gases will be accurately measured by the weight of the mercurial column suspended in the longer arm of the barometer, above the level of the mercury in the basin; care being had to allow for any variation in the capacity of the receiver, arising from alteration in the level of the mercury in the basin, and likewise for the small tension always indicated by the barometer immediately previous to the introduction of a fresh gas, arising from the impossibility of forming a perfect vacuum.

If an approximate vacuum be formed in the receiver enveloping the basin of the barometer, and a small quantity of any liquid be then introduced, it will be immediately converted into vapour, and the elastic tension of this vapour will be measured in precisely the same way as that of permanent gases. The receiver is sometimes of sufficient size to contain animals and plants, the effect of which in increasing or diminishing the tension of the enclosed gas is then measured by the rise or fall of the mercury. If this manometer be transported from one place to another, where the temperature is the same, but the force of gravity different, this variation in the force of gravity will be manifested by a corresponding variation in the length of the mercurial column; that is, if the gravity increase, the tension of the enclosed gas will be counterbalanced by a shorter column of mercury, and the contrary; but as this method of measuring the variations in the force of gravity is not susceptible of that accuracy which is attained by the employment of the pendulum, it is rarely if ever resorted to.

The exact determination of the elastic force of aqueous vapour at high temperatures being essential to the safe construction and management of steam-engines, the French government requested the Royal Academy of Sciences to institute a course of experiments, with a view to the attainment of so important an object. The care of making these experiments was confided by the Academy to MM. de Prony, Arago, Girard, and Dulong, who made their report in 1830 ('Annales de Chimie,' t. xliii., p. 74.) The manometer constructed for this purpose consisted of a straight glass tube of uniform bore, 1·7 mètres (67 inches) in length, and 5 millimètres (1·25 inches) in diameter and thickness, closed at the upper and open at the lower extremity. The capacity having been accurately determined, it was filled with perfectly dry air of known density, and enveloped in a cistern of water, which was kept at a uniform temperature. Another tube of equal bore and thickness, but 26 mètres (85 feet) in length, and open at both ends, was then erected, and the lower extremities of the two tubes were made to communicate with apertures in the opposite sides of a cylindrically-shaped reservoir, capable of holding about 1 cwt. of mercury. By means of a forcing-pump adjusted to the top of this reservoir, the pressure upon the surface of the contained mercury could be increased at pleasure; and this increased pressure, being transmitted to the lateral apertures already mentioned, would obviously cause the mercury to rise in both tubes, but to unequal heights; for in the longer tube it would rise until the weight of the mercurial column, together with that of the superincumbent atmosphere, were equal to the pressure; but in the shorter tube, only until this pressure was counterbalanced by the rapidly augmenting expansive force of the confined air, added to the weight of the small column of mercury forced into it. The expansive force of the compressed air would be measured by the difference of these two columns; and by this means, the shorter tube having been carefully graduated corresponding to pressures varying from one to twenty-nine atmospheres, the construction of the manometer was complete. The longer tube and the forcing-pump were then removed, as no longer necessary, and instead of the latter was substituted the actual pressure of steam at successively increased temperatures, the tension of which was indicated by the compression of the air in the manometer.

The French apply the term manometer to any apparatus which measures the pressure of aeriform bodies, such as the pressure-gauge of a steam-engine or of a gasometer. They distinguish three classes of manometers, namely, *le manomètre à air libre*, *le manomètre à air comprimé*, and the metallic manometer. The open air manometer consists of a glass tube of about five mètres in length, one end of which is cemented into a cast-iron cistern containing mercury. Parallel with the glass tube is a tube of iron four mètres in length, the lower extremity of which passes by a lateral opening into the mercury cistern. This iron tube is filled with water, which transmits the pressure of the steam, &c., to the mercury, the ascent of which in the glass tube marks the pressure in atmospheres and tenths. This form of instrument is not used for greater pressures than those of five or six atmospheres. In Cazalet's manometer the steam is made to act on the sectional area of the rod of a piston, the plunger of which, of much greater sectional area, presses on and so sustains in the other leg of the inverted siphon into which it plunges a mercurial column of sectional area equal to its own. The compressed air manometer is based on the law of Mariotte, that the volumes of gases are inversely as their pressures. It consists of a glass tube closed at its upper extremity, filled with dry air, and fastened securely in an iron cistern containing mercury, from which proceeds a side tube which is connected with the boiler, or vessel containing the vapour whose elastic force is to be measured. Any pressure acting through this tube on the surface of the mercury in the cistern will force it up the tube, which is graduated according to the above law, and by its indications gives the pressures put in operation.

The metallic manometer of M. Bourdon is constructed on the same principle as his metallic barometer [BAROMETER], namely, that when a tube with flexible sides and slightly flattened is rolled into a spiral form in the direction of its smallest diameter, any internal pressure on the sides tends to unroll the tube, while any external pressure tends to roll it up more closely. In this manometer the curved tube is of brass, 0·7 mètre in length, of long flattened oval section, the major axis being 11 millimètres and the minor 4 millimètres in length. To one end is attached a tube and a stop-cock for putting it in communication with a steam-boiler; the other end is closed, and carries a needle, the arrow of which moves over a graduated scale representing the tension of the vapour in atmospheres. Vapour being admitted the pressure causes the spiral to unroll, and in doing so the needle is carried over the scale. This instrument has the advantage of being portable, and not fragile, and hence is used in connection with locomotive boilers.

MANOR (*Manerium*).

I. *Origin of Manors.*—At the time of the Norman conquest manerius or manerium (from *manere*, to dwell) denoted a large mansion or dwelling. The "manerium" of the Exchequer Domesday is the "mansio" of the Exeter Domesday, each being therefore the equivalent of the Anglo-Saxon or French term used by the officers who made the survey. [EXETER DOMESDAY.] In France the corresponding word "manoir" has never acquired any other signification than that of a mansion; and an estate possessing the peculiar incidents of an English manor never became so common in France as to require a specific name.

The modern English manor derives its origin from subinfeudation [FEUDAL SYSTEM], as it existed before the modifications of the system of tenures introduced in 1225 by Magna Charta, and the still more important alterations made in 1290 by "The King's Statute of buying and selling Lands," commencing with the words "Quia Emptores Terrarum," and in 1824 by the statute 'De Prærogativâ Regis,' by which statutes, the process of subinfeudation, or of granting land, &c. in fee-simple, to be held by the grantee as a tenant or vassal to the grantor, was stopped.

Where a subinfeudation made by A to B extended to the whole of A's land, nothing remained in A but a seigniory with the ordinary feudal incidents of tenure, together with such rents or other services as might have been reserved upon the creation of the subtenure. This interest in A was a seigniory in gross, that is, a seigniory held by itself, unattached to any land, an incorporeal seigniory, termed by the French feudists "un fief *en l'air*." But in the case of subinfeudation of *part* of the land, the ordinary mode of proceeding was this:—A, a large proprietor, having a mansion and land at Dale, created a subtenure in a portion of his land by granting such portion to B and his heirs, to hold of A and his heirs, as of A's manerium (mansion) of Dale, which words created an implied condition that B should perform the service of attending, with the other tenants of A holding by virtue of similar subinfeudations, at A's halmote of Dale, that is, at A's court meeting in the hall of A's mansion at Dale (afterwards called A's court-baron of his manor of Dale), for the purpose of deciding judicially all disputes among A's free tenants holding of him by the same tenure as B, in respect of their lands so holden, and also all actions brought by persons claiming such lands.

Upon this subinfeudation being effected, A would continue to be the owner of the mansion of Dale and of that part of the land of Dale, of which he had made no subinfeudation, in demesne (in dominico suo),—as his own immediate property; and he would have the seigniory of lands of which B and others had been subinfeoffed, as a seigniory appendant or legally annexed to the mansion of Dale, and to the demesnes of Dale, of which the mansion formed part.

This conjoint or complex estate, taking its denomination from the mansion (manerium), which was considered as its head, and which, in the language of the Year Book of 14 Edward II. (Maynard, 426), "drew to itself all the appendancies," by degrees acquired the name of manerium or manor.

A manor therefore *originally* consisted of lands in demesne, upon which the lord had a mansion, and to which lands and mansion, and more especially to the latter, there was appendant a seigniory over freeholders qualified in respect of quantity of estate (that is, by a tenancy for life at the least, if not a tenancy in fee-simple), and sufficient in point of number, to constitute a court-baron. These freeholders were called vavassors [VAVASSOR], and their lands "tenemental lands," that is, lands granted out in tenure, to distinguish them from the lord's demesnes. These tenemental lands, anciently known by the denomination of vavassories, though held of the manor and within the seigniory (or, as it was usually termed, within the fee) of the lord, were not considered as part of the manor; but the services issuing from such tenemental lands were part of the manor and essential to its existence.

Afterwards it was sufficient if the site of a mansion at which the services had been reserved, or as it was called, the site of the manor, formed part of the demesnes; and, at last, this vestige of the origin of the name of the estate was dispensed with, and if the lord retained any portion of the land, so that there would be some demesnes to which the seigniory over the freehold tenants of the manor, and the services rendered by them, might continue to be appendant, the compound estate called a manor was not dissolved, whether it could be shown that a mansion had ever stood on the part of the demesnes or lands retained, or not, and even if the lord had aliened and severed from his demesnes the spot on which the mansion had once stood.

II. *Nature and incidents of Manors.*—A manor is commonly said to consist of demesnes and services. It is quaintly, but perhaps more correctly stated by Fulbeck, that these "are the material causes of a manor;" for though there can be no manor unless there be both demesnes and services, other things may also be members and parcel of a manor.

1. The demesnes are those lands within the manor, of which the lord is seised, that is, of which he has the freehold, whether they are in his own occupation, or in that of his tenants at will, or his tenants for years. The tenants at will have either a common-law estate, holding at the joint will of the lessor and of the lessee, or a customary estate, holding at the will of the lord according to the custom of the manor. [COPYHOLD.] The tenancy for years of lands within a manor is, in modern times, usually a common-law estate, though in the assessionable manors, parcel of the duchy of Cornwall, customary estates for years still subsist (VIII.); and where a copyholder surrenders for years, the surrenderee becomes a customary tenant for years of the portion of the demesnes so surrendered.

2. The services of a manor are, the rents, and other services, due from freehold tenants holding of the manor. These services are annexed or appendant to the seigniory over the lands holden by such freehold tenants. The lands holden by the freeholders of the manor are holden *of* the manor, but are not *within*, or *parcel of*, the manor, though within the lord's fee, or manerial seigniory.

Copyholds, being part of the demesnes, are not held of the manor, but are within and parcel of the manor.

The demesne lands were formerly called the *inland*, and the tenemental lands, the *outland*, of the manor.

3. But though a perfect legal manor cannot exist without demesnes and services, other incorporeal hereditaments, which are not services, may be parcel of the manor, as advowsons, rights of common, rights of way, &c., and, under peculiar circumstances, even rents-seck and rents-charge.

In general, the power of holding courts of justice, whether for the decision of criminal matters or for the determination of civil rights, can be exercised only under authority derived from the crown, either by actual grant or by prescription; and in order to prevent usurpations of such a power, the crown may at any time issue process for the purpose of instituting an inquiry by what authority [QUO WARRANTO] a subject holds a court of justice. But it is a distinguishing feature of the feudal system, to make civil jurisdiction necessarily, and criminal jurisdiction ordinarily, coextensive with tenure. Upon this principle there is inseparably incident to every manor a court-baron (curia baronum), being a court in which the freeholders of the manor are the sole judges, but in which the lord, by himself, or more commonly by his steward, presides. The jurisdiction of the court-baron extends over all personal actions in which the debt or damages sought to be recovered are under 40*s.*; and real actions in respect of lands held of the manor could not have been brought in any other court, except upon an allegation that the lord of the manor had in the particular instance granted or abandoned his court to the king (quia dominus remisit curiam). To a quo warranto therefore for holding a court-baron, it is a sufficient answer—that the defendant has a manor. As this court was essential to the due administration of justice in questions respecting the right of property held of the manor arising amongst the lord's tenants, there could never have been a perfect manor without a sufficient number of freeholders to constitute the court-baron, which number must consist of three, or two at the least; three being necessary where the litigation was between two of the freeholders.

4. Some things are popularly supposed to be incident to a manor, which have no necessary connection with it. Thus the ownership of wastes within the district over which the manor extends, is frequently called a *manorial* right, though the right and interest of the lord in wastes, over which no acts of ownership can be shown to have been exercised by him, rests entirely upon the presumption in favour of the lord, arising out of the circumstance of his being the present owner of the demesne lands, and the former owner of the tenemental lands which adjoin such wastes. The same presumption would arise in favour of any other owner of an extensive district. It is however true that lords of manors in their original grants, both to their freehold and to their copyhold tenants, usually reserved the waste lands, giving to the freeholders and copyholders merely rights of common over the wastes. Hence it arises that, in point of fact, manors, in proportion to their extent, frequently contain a much larger portion of wastes than other estates.

Copyholds are a common incident to the demesnes of a manor, but there are many manors in which this species of tenure does not appear to have ever existed, and many more in which it has been long extinct; and though there are now no copyholds unconnected with a manor, the custom of demising by the lord's rolls appears to have formerly been common to every lord or freeholder who had demesnes which were held in villenage. So the right to have a court-leet is a royal franchise [LEET], under which the grantee holds a court of criminal jurisdiction in the king's name, over the resiants (residents) within a particular district. This privilege may be granted to persons who are not lords of manors; and where the grantee has a manor, the limits of the manor and of the leet are not always co-extensive.

III. *Manors, how created.*—Since the statutes of Quia Emptores and De Prærogativâ Regis no manors have probably been created; and it has been commonly said that no new manor could afterwards be created. But as a proposition of law this appears to be stated too broadly. The former statute has been held not to apply to the immediate tenants of the king, who is not one of the "magnates and other (that is, inferior) lords." The latter statute speaks only of lands held by knight's-service, and therefore, like the clause in the statute of wills imposing a restriction upon the devising of lands of that tenure, appears to be inapplicable since the abolition of military tenures. Besides, the statute of Quia Emptores Terrarum has been held to contain an implied exception in respect of alienations made with the licence of all lords, mediate or immediate; and in the statute De

Prærogativâ Regis we find an express exception in favour of alienations made with the licence of the king. It seems to be questionable whether, even by the common law, the immediate tenant of the crown did not incur a forfeiture by making a subfeoffment without licence. (34 Edw. III., c. 15.) It has also been objected that a court-baron is necessary to a manor, and that a man cannot, by granting lands in tail, reserving suit at his court, create a court-baron. But this objection assumes that no greater subtenure can now be created than an estate tail; whereas, *with licence*, a subtenure in fee may be created, and the holding of a court-baron seems to be incidental at common law to the seigniory over tenants in fee-simple.

Practically however no entirely new manors are now created; but where, upon the partition of a manor, part of the demesnes and part of the services, including suit of court of a sufficient number of freehold tenants to constitute a court-baron, are assigned to one parcener, joint-tenant, or tenant in common, and other parts of the demesnes and services to another parcener, &c., each party has a manor, and may hold a court-baron. And it is said that if a manor extends into several townships, the lord may create separate manors by conveying the demesnes and services in township A to one, and those in township B to another.

IV. *Manors, how destroyed.*—A manor is not destroyed by the loss of those incidents which, though members, and forming part, of the manor, are not, like demesnes and services, the "material causes of a manor." Nor will the legal existence of the manor be affected by the alienation of *part* of the demesnes, or by the alienation or extinction of *part* of the services, or by the extinction of all the copyholds. But upon the alienation of all the demesnes, or the alienation or extinction of all the services, the manor ceases, and is said to be destroyed: and though any part of the demesnes, however small, will keep alive the manor, if there be sufficient services, it can exist no longer than whilst there can be found enough freehold tenants to constitute a court-baron. Thus if the lord purchase the lands of all his freehold tenants, or of all except one, or if the freehold escheat, or if the lord release or alien the services, the manor ceases to exist. So, if the lord alien the freehold of all lands holden of him by copy of court-roll, or enfranchise all the copyholders, in a manor where there are no demesnes except the copyholds. So, if he alien all the demesnes. So if, upon a partition of the manor, the demesnes are allotted to one and the services to another. But in none of these cases is the destruction of the manor absolute and irrevocable. If there cease to be any demesnes, so that the manor is turned into a seigniory in gross, yet upon the event of any of the freeholds holden of the manor coming to the lord by escheat or purchase, the lands so escheating or purchased will become demesnes of the manor, as they were, before the subinfeudation of those lands, whereby they were originally severed from the manor, took place. Where a manor is destroyed by partition between co-parceners, if one die, and the other takes the share of the party dying as heir, the manor revives; but it would not be so in the case of a partition between joint-tenants or tenants in common, nor would the manor revive in the case of co-parceners if the severed portion of the manor were re-united, not by descent, but by purchase. Where all the freehold tenants have ceased to exist except one, there is no longer a complete legal manor, because there can be no court-baron; but if the remaining tenant convey his tenement in fee to different persons in severalty, as there will be now a sufficient number of freeholders holding of the manor, to constitute a court-baron, the manor will revive. But without such revival, the estate is by some lawyers considered to be still entitled to the designation of a manor, by reason of there being demesnes and a seigniory appendant, though over one tenant only. (1 'Anderson,' 257.) Such an estate is however more frequently called "a manor by reputation,' a vague term, applied indiscriminately to all estates which have been manors, and which indeed would be equally applicable to a property which had acquired the name of a manor without having ever been one.

V. *Manors, Customary.*—So much importance formerly attached to the possession of a principal mansion at which the services of tenants might be rendered, that a person holding lands in customary villenage might grant portions of his villenage to be holden of the grantor, for as great an estate as the grantor had, as of his mansion or manerium. The estate of the grantor, which, after this operation, would consist of the mansion and the other ungranted portions of the villenage, with the services of the grantees appendant thereto, was called a customary manor.

The estate of a person to whom the lord of a manor has granted the freehold and seigniory of all the copyholds within the manor or within a certain district, has been sometimes loosely called "a customary manor." But such an estate cannot, in any sense, be said to consist of demesnes and services.

VI. *Manors in Ancient Demesne* are those manors which, though now mostly in the hands of subjects, formed part of the royal domain at the time of the Conquest, and are designated in Domesday as "terra regis." The peculiarity of these manors is, that there exists in them a particular class of tenants possessing certain customary privileges, supposed, by Lord Coke and others, to be derived from the indulgence of the crown in matters "pertaining to the king's husbandry." They were formerly called "tenants in socage in ancient tenure," but are now commonly known as "tenants in ancient demesne," a term not in itself very accurate, since all tenants within these ancient demesne manors, whether copyholders or leaseholders, and even the lord himself, are strictly speaking tenants in ancient demesne. In these customary tenures the freehold is not in the lord, but in the tenant, who is therefore called a customary *freeholder*; and it does not appear to be necessary to the continuance of the manor that there should be any other freehold tenants, though lands may be held of a manor in ancient demesne by the ordinary freehold tenure, which lands are called lands in frank-fee by way of distinguishing them from the customary freeholds held by the "tenants in socage in ancient tenure," now called "tenants in ancient demesne."

VII. *Manors in Border Counties.*—The exposed state of the northern borders of England, liable to hostile incursions in time of war, and scarcely less in times of nominal peace, created a peculiar species of tenure in the manors in the four northern counties. Persons holding by this tenure are called customary freeholders; though here the *freehold* is in the lord, and the timber and mines belong to him, and not (as in the tenure in ancient demesne) to the tenants; but they are so called because they are allowed the privilege of passing their estates, as freeholders do, by feoffment and livery, a privilege perhaps derived from the irregularity with which the customary courts of the manor were held, and from the necessity of allowing persons whose tenure of land and of life was so uncertain to make immediate dispositions of their property.

VIII. *Manors, Assessionable.*—A term peculiar to that part of the domain of the Duke of Cornwall [Wales, Prince of] which is situate within the county of Cornwall, consisting of seventeen manors, namely, Launceston, Trematon, Tyntagell, Restormel, Stoke-Climsland, Tybeste, Tewington, Helston-in-Kerrier, Moresk, Tywarnhaile, Penkneth, Penlyn, Rellaton, Helston-in-Trigshire, Liskeard, Calstock, and Talskydy.

The earls and dukes of Cornwall, and, when no earl or duke, the crown, have sent from time to time (commonly every seven years) certain persons commissioned to visit these manors in succession, and to *assess* the lord's demesnes, that is, to let them at such rents and upon such terms as might appear to them to be advantageous to the duchy. The courts held by the commissioners for the purpose of exercising the authority thus delegated to them were called *assessions*, or courts of *assession*. The course usually was to let the land until the next assession. From the conventions (covenants or engagements) entered into by the persons to whom those demesnes were so arrented, the interest demised was called a tenure *in conventione*, and the tenants were styled conventionaries. These demises were made both to freemen and villeins; the former being called free conventionaries, the latter villein or native conventionaries. The latter class appears to have become extinct in the 16th century.

By degrees the conventionary tenants acquired an inheritable interest in the certainty of the renewal of their holdings in favour of themselves and their descendants at each successive assession. The conventionary tenant thus acquired, like a copyholder of inheritance, an interest freehold in point of duration, without a freehold tenure.

In conventionary tenements the minerals belong to the lord, and not to the customary tenant; as it was held upon a trial at bar in 1829, which lasted seven days (Rowe *v.* Brenton, 3 Mann. and Ryl., 133-364).

MANSLAUGHTER. [Murder.]

MANU (a word which implies "rational," from *man*, to "understand"), according to a Hindu fiction, was the son or grandson of the creating deity of Brahmâ, the first of rational beings, and the progenitor of mankind, who thence are called Mânavâs, or Manujâs (offspring of Manu). To this primeval sage, the father of the human race, and consequently their patriarchal ruler and legislator, is ascribed a celebrated system of religious and civil law, which in the beginning of time was revealed to him by Brahmâ, and has been handed down by tradition to the present age. In other words, the Sanskrit work now extant, and indiscriminately called Smriti (tradition), or Mânava-dharma-sâstra (the Institutes of Manu), is deemed by the Hindus not only the oldest but at the same time the holiest text after the Vedas. Before these pretensions of the sacred code to antiquity and authority can be duly appreciated, it will be convenient to state its contents, and to point out the leading features of a system at once so comprehensive and so complicated that it would be almost impossible to dwell upon its particular precepts without entering fully into the labyrinth of Hindu religion and ceremonies. The work is divided into the twelve following chapters:—i. On the creation; ii. On education, or on the first order; iii. On marriage, or on the second order; iv. On economics and private morals; v. On diet, purification, and women; vi. On devotion, or on the third and fourth orders; vii. On government, and on the military class; viii. On judicature, and on law, private and criminal; ix. On the commercial and servile classes; x. On the mixed classes, and on time of distress; xi. On penance and expiation; xii. On transmigration and final beatitude.

We shall not dwell on the first or last chapter; the first is occupied with a summary of the contents of the whole code, and with a problem of cosmogony, in accordance with the wild and fanciful conceptions of Hindu metaphysics and natural philosophy; the twelfth chapter contains a detailed system of metempsychosis and final punishments, closely connected with the institutes of temporal law. It is obvious that either a strict order in the arrangement of the judicial code has been neglected, or, what is more probable, the monarchical and civil laws (vii.-xi.) have purposely been separated from the general duties contained in the first half of the work. These for the most part are of a religious character, being engrafted on the most rigid distinction of caste, and therefore totally dependent upon the hierarchical rules of the first order, by which even the minutest actions of the inferior classes are invariably to be regulated. Without entering into the mass of formalities and customs by which the main structure of the Brahminical, and in fact of every hierarchy is largely cemented, and into those generally absurd and often ridiculous ceremonies inculcated upon the different branches of society, it will be sufficient to remark that they were evidently congenial to the religious prejudices, and to the habits and disposition of the Hindus, and that most of them had long been sanctioned when the sacred code was promulgated. This is expressly asserted by the author himself, who professes to give the system of law in its full extent, and the immemorial customs of the four classes, adding that immemorial custom is transcendent law, approved in sacred scripture, and that holy sages have embraced good usages long established. The principal duties of the four classes in general are stated as follows:—

To the first, or sacerdotal order, the supreme ruler assigned the duty of reading the Veda, and of teaching it; of giving advice to kings, of sacrificing and of assisting others to sacrifice, of giving alms and of receiving gifts, of promoting justice on earth, and of procuring happiness hereafter; in short, a Brahmin must ever be intent on divine worship, devotion, austerity, and abstinence. It is only in case of need that he is allowed to support himself by tillage or traffic, but never by service for hire. Although he is by right the chief of the whole creation, and, whether learned or ignorant, must be revered as a powerful divinity, nevertheless he should constantly shun worldly honour, and rather seek disrespect and poverty.

The Kshatriya, or military class, is bound to defend the people, to read the Veda, to sacrifice and to give alms; the Vaisya caste to cultivate land, to keep herds and flocks of cattle, to carry on trade, to lend at interest, to sacrifice, to read the scriptures, and to bestow presents. The business of the fourth, or Sudra class, is only to serve the three upper orders, and chiefly the Brahmins.

Now in these four classes, which may be called the pillars of Hindu society, those only who are born of wives equal in caste are to be considered as of the same class with their fathers. But by intermixture and marriage with women who ought not to be married, and by the omission of prescribed duties, a great number of impure classes have been formed, which in their turn are obliged to perform strictly the special rules and obligations enjoined on their caste, or else they will sink to a still lower degree in the scale of human society. These mixed classes are enumerated at large in the tenth chapter, and prove a far advanced state of civilisation by the very great variety of professions which they exhibit. But as even the aboriginal tribes and the inhabitants of adjacent countries are asserted to have gradually sprung from the same source, we need scarcely remark that the institution of caste carried to this extent must be altogether imaginary; and moreover that a system of law founded on these vague and fanciful principles must be a partial and degrading one. Hence the punishments, consisting of pecuniary fines and confiscation of property, of mutilation of the body, and death, of exile and loss of caste (which is deemed moral death), are inflicted according to the privileges of the different classes; in general these punishments are slight and trifling for the highest order, but dreadfully severe and cruel for the same crimes when committed by an individual of inferior caste. Thus a soldier who defames a priest shall be fined a hundred panas, a merchant a hundred and fifty, but a mechanic or servile man shall be whipped; and while the slaying of a Sudra by a man of the sacerdotal class is exactly equivalent to the killing of a cat or dog, the murder of a Brahmin is an inexpiable crime, and he who barely assaults a priest with intention to hurt him shall be whirled about for a century in a place of future punishment, which is described as "a dark hell."

With regard to the penal provisions of the criminal law we shall only observe that in most of them the principle of retaliation has been sanctioned; for instance, whoever breaks a dam or sluice, by which an inundation would be caused (Buchanan, 'Mysore,' i., 4), shall be drowned; an adulterer shall be burned on an iron bed; a cut-purse is to lose two fingers, and "with whatever limb a thief commits the offence, even that limb shall the king amputate" (viii. 334; ix. 273, ff.). Nevertheless most of the punishments may be commuted for pecuniary fines; and in case a temporal chastisement proves unavailing, threats of future pain are often held out. A priest may by muttering imprecations and holy charms chastise those who injure him, without complaining to the king. In short, the first part of the sacred code is entirely what we should call hieratical. This character is apparent not only in its inflexible severity where religion and its ministers are concerned, and the well-calculated distinction of castes, by which a free intercourse between the members of society would be prevented, and consequently a more close dependence on the priesthood ensured, but also in the spirit of sublime devotion, of benevolence and tenderness to all sentient creatures, by which sacerdotal institutes are generally distinguished.

The second part of the code, containing the monarchical and civil laws, is more congenial to social order, and although the same spirit of hierarchy prevails, it is often checked by rules of a sound policy and of regular administration. The king, born in the military class, is formed of particles drawn from the substance of the guardian deities; surpassing all mortals in glory, he is himself a divinity in a human shape, and consequently he must be the protector of all classes who discharge their duty (7, 4. 9, 301 ff). "He must invariably speak truth and never transgress the rule of strict justice; but as just punishment cannot be inflicted by an ignorant and covetous king, he has to learn the science of criminal justice and of policy, the system of logic and metaphysics and sublime theological truth from learned priests, and from the people the theory of agriculture, commerce, and other practical arts." Nothing is so often and so strongly inculcated by Manu as the equity and justice of kings in protecting the property of their subjects against fraud and violence. For this purpose the prince shall appoint a governor of one town with its district, another of ten towns, of twenty, of a hundred, and above all these inferior authorities, a high officer, whom we may perhaps call a lord-lieutenant, over each thousand towns. Also, to prevent the people being oppressed, a superintendent of all affairs shall be established in every large town to inspect the inferior officers. A large number of laws for the mercantile tribe, with rigorous regulations about the sale and purchase of marketable things, about weights and measures, tolls and freights for boats passing up and down rivers: the severe punishment of robbers and of those who will not restore loans and deposits, and the most subtle definitions of the law of inheritance—all tend to show that, however restricted by the rules of caste the social and personal condition of an individual might be, his property at least was respected and held inviolable. As to the laws of succession, it is laid down as a fundamental rule, probably derived from ancient patriarchal manners, that, if possible, the whole property of the family should be kept together. Accordingly after the death of his father, the eldest son may take entire possession of the patrimony, and the others may live under him, unless they choose to separate. In this case, the widow and such persons as by crimes or mental or corporal defects are legally excluded from participation, being provided for, the heritage is divided into portions according to the minute and almost endless variety of regulations by which, owing to the real or imaginary intermarriage and mixture of classes, this part of Hindu law has become extremely abstruse and intricate. Property belonging to a sacerdotal student and a minor must be guarded by the king, until the owner shall have concluded his studentship, or until his infancy shall have ceased in his sixteenth year. No tax is levied or charge made for this trusteeship nor for any tuition whatsoever; and except custom-duties and market-taxes, the only legal tax or annual revenue which a sovereign may receive from his whole dominion through his collectors is imposed on the mercantile and agricultural classes. He may take either a twelfth part of the crops, or an eighth, and in time of distress even a fourth part, but in every respect he must act like a father to his people. (7, 80, 10, 118 ff.) Serving men, artisans, and mechanics never pay taxes, but they must occasionally assist by their labour when needed. According to a theory most rigorously supported in a rude state of feudal and despotic government, by several Hindu lawgivers of modern times, and even by a passage in Strabo, the king has been declared sole possessor of the soil ('Digest of Hindu Law,' 1, 460; Strabo, p. 1030, ἔστι δὲ ἡ χώρα βασιλικὴ πᾶσα). But although the sovereign's right to an annual ground-rent, and his gifts of land, so often recorded in inscriptions and written documents, may originally have been founded on such a doctrine, its practical application would have proved ineffectual, and in fact it is nowhere adopted nor even mentioned by the sacred code. On the contrary, it is expressly stated as a rule laid down by ancient sages, that cultivated land shall be the property of him who has cut away the wood, or who has cleared and tilled it (9, 44). To prove the inviolability of the tenure of land, in which the proprietor is rather protected than limited by government, many special laws might be produced, such as those concerning landmarks and boundaries, the common ponds by which the fields are watered, the punishment inflicted on herdsmen and owners for injuring cattle; and so far is the agricultural tenant from being disturbed in his possession, that even if land be injured by his neglect, he shall only be punished by a heavier tax.

The most striking feature by which, on the whole, and notwithstanding its many glaring defects, this code is distinguished, is the rigour and purity of its morals. A complete system of ethics might be gathered from the scattered moral sentences, of which we subjoin the following few examples. "Let not a man be querulous, even though in pain; let him not injure another in deed or in thought, let him not even utter a word by which his fellow-creature may suffer uneasiness (2, 161). Let him bear a reproachful speech with patience; let him speak reproachfully to no man; with an angry man let him not in return be angry; abused, let him speak mildly (6, 47). Let him say what is true, but let him say what is pleasing; let him speak no disagreeable truth, nor let him speak agreeable falsehood (4, 138 ff.). Though oppressed by penury, in consequence of his righteous dealings, let him never give his mind to unrighteousness (4, 171); let him be firm in his contentment and check all desire of acquiring more than he possesses, for happiness has its root in content, and discontent is the root of misery (4, 12). A wise man should constantly discharge all the moral duties, though he perform not constantly the ceremonies of religion (4, 204); he should act without any view of reward, and constantly shun religious hypocrisy, for he who describes himself to worthy men in a manner contrary to truth is the most sinful wretch in the world; he is the worst of thieves, a stealer of minds (4, 255). Even here below an unjust man attains no felicity, nor he whose wealth proceeds from giving false evidence; for the soul itself is its own witness: offend not thy soul, the supreme internal witness of men. The sinful have said in their hearts 'No one sees us.' Yes, the gods distinctly see them, and so does the spirit within their breasts (4, 170; 8, 84). He who perseveres in good actions, in subduing his passions, in bestowing gifts, in gentleness of manners, who bears hardships patiently, who associates not with the malignant, who gives pain to no sentient being, obtains final beatitude (4, 246; 12, 10). Single is each man born, single he dies, single he receives the reward of his good, and single the punishment of his evil deeds. When he leaves his corpse, like a log or lump of clay on the ground, his kindred retire with averted faces, but his virtue accompanies his soul" (4, 240). The principal moral duties in general are summed up in the following passage: "The avoiding of all injury to animated beings, veracity, the abstaining from theft and from unjust seizure of property, cleanliness and command over the bodily organs, form the compendious system of duty which Manu has ordained for the four classes" (10, 63). To conclude with the words of Sir William Jones: "The work contains abundance of curious matter, extremely interesting both to speculative lawyers and to antiquaries, with many beauties which need not be pointed out, and with many blemishes which cannot be justified or palliated; it is a system of despotism and priestcraft, both indeed limited by law, but artfully conspiring to give mutual support."

The time at which the laws of Manu were composed is wholly uncertain, and it was only from conjecture that the eminent Sanscrit scholar whom we have just named fixed the 12th century B.C. as the probable epoch of their composition. Generally speaking we may safely pronounce it the code of an already refined and enlightened people, and the work itself bears ample testimony that a very advancing degree of civilisation had been acquired by the Hindus when these laws were promulgated. But what is most important, is that the burning of widows is totally unknown: on the contrary, a widow is legally bound to devote herself to pious austerity, and may even be lawfully married to the brother of her deceased husband, as she could marry any other man during the reign of king Vena (3, 173; 5, 157). Now the duties of a Satti, so minutely detailed in works of later date, could not possibly be omitted in a sacred code of law, and therefore the work seems at least anterior to the invasion of India by the Macedonians, who were fully acquainted with these horrid sacrifices.

The learned Hindus agree that many laws enacted by Manu were confined to the first three ages of the world, and have no force in the present age; some of them have been abolished or modified by subsequent Hindu lawgivers, according to whom the work is rather to be honoured than to be strictly followed. In fact for a long time it has formed only a very small part of the juridical system, and may be considered as the oldest text-book of law extant, or as the Hindu 'Institutes,' preparatory to the copious 'Digests,' 'Pandects,' and other legal works now in use among the different juridical schools in India. (Ellis, in 'Madras Transactions,' vol. i., and Sir Thomas Strange, 'Hindu Law, principally with reference to such portions of it as concern the Administration of Justice in the King's Courts in India,' Lond., 1830.)

The 'Institutes' of Hindu law, or the 'Ordinances of Manu,' were verbally translated from the original by Sir William Jones, 1794. The Sanscrit text with the gloss of Kullûkabhatta was published at Calcutta in 1813, and a new edition of the metrical text, together with Sir William Jones's translation, carefully collated with the original, was prepared by Sir Graves Haughton, 1822, 1825. Another valuable edition was published in Sanscrit, with select notes and various readings, at Paris, in 1830, and a French translation with notes and explanations, both by Loiseleur des Longchamps, at Paris in 1833.

MANUMISSION. [LIBERTINUS; SLAVE.]

MANURE. Every substance which has been used to improve the natural soil, or to restore to it the fertility which is diminished by the crops annually carried away, has been included in the name of manure. Thus chalk, marl, clay, and even sand, when added to the soil for the purpose of improving its texture, have been called manures; and some confusion has arisen in our ideas in consequence of applying the same word to signify things which are essentially different. The French have a term by which they distinguish the substances which merely improve the mechanical texture of the soil from those which act more directly in nourishing the plants which grow in it. The former of these they call *amendements*, and the latter *engrais*.

It is well known to all practical agriculturists that the texture of the soil and the proportions of the earths of which it is composed are the first and most important conditions of its productive powers. When there is a good natural loam which retains moisture without becoming wet or overcharged with it, and permits the influence of the atmospheric air to pervade it, the crops cannot fail to be more certain and remunerating than in loose sands or tenacious clays, however rich they may be in those substances which are supposed to supply the elements from which the juices of plants are chiefly composed. But, at the same time, it is equally true that the best texture of soil will not produce good crops for any length of time without the help of some other rich manure to recruit the loss produced by vegetation.

The various means of improving the texture, such as tillage and the mixture of earths, are treated of separately. [LOAM; MARL; SOIL; TILLAGE.] We shall here confine our observations to that class of manures which stimulate or enrich the soil.

There are some substances which evidently belong to both classes of manure. Of these, lime, either in its caustic state of quick-lime or its milder form of a carbonate or chalk, is the principal. Lime, being an earth less porous than sand, and more so than clay, has an improving effect on soils in which either sand or clay prevails; but it has also a chemical effect as an alkaline earth; and, considered in this light, it acts on the soil in a peculiar manner, and greatly assists the effect of enriching manures, which are all of animal or vegetable origin.

Lime as a manure acts most powerfully in its caustic state—that is, when deprived of the carbonic acid which is generally united with it. The carbonic acid is expelled by the heat of the kiln, and limestone is by this means reduced to the state of quick-lime, in which it has so strong an attraction for moisture and carbonic acid, that, if it be left exposed to the atmosphere for any length of time, it absorbs both from it, and gradually returns to the state of hydrate and carbonate, or lime united with water and carbonic acid, with this difference, that it is now a fine impalpable powder, instead of a hard stone.

Among the purposes it serves, and besides its use as a direct food of plants, are those comprised in its relations to the dormant and mischievous ingredients of soils; its power to detach serviceable alkaline matters from useless positions in the soil; its power to induce the decomposition of vegetable matter there; its power to decompose and render harmless mineral and metallic salts of a mischievous character; its uses in detaching ammonia from comparatively insoluble compounds of it, and so presenting portions ready for immediate use by the plant; its influence in possibly increasing the power of soils to absorb ammonia from the air.

Besides all this, its influence on the texture of the soil, on the growth of weeds, on the general fertility of the land, on the growth especially of particular crops, on the health and soundness more especially of the turnip crop, should be also named.

The use of frequent limings in small doses, as compared with larger dressings at longer intervals, depends on the quantity of vegetable matter in the soil, but the larger dressings are generally to be preferred, on the grounds that in practice the full influence of a liming is not seen until after several years, and that the abundant fertility which, when lime is properly used, is consequent upon its use, may, when rightly managed, be made to reproduce itself, and so become permanent. The abuses to which it is liable are, chiefly, its application to soils deficient in vegetable matter, and its application along with manure rich in ammoniacal matters. But a distinction may be drawn between rotten dung and recent farm manure in this respect,—the application of hot lime along with the former being wasteful, but along with the latter by no means uneconomical. There are many modes of applying lime, as slaked or unslaked,—in compost with vegetable matter of any kind, or directly to the land, ploughed in deep or shallow, in quantities of 40 or of 240 bushels per acre,—previously to a corn crop or a green crop,—on a corn or clover stubble, &c. One of the best rules of practice is, to apply it where there is the greatest quantity of undecomposed vegetable fibre in the soil; and, acting on this rule, the best time in the rotation for the application of lime is on the clover stubble or the grass layer previous to ploughing it up for a grain crop.

The use of quick-lime in rendering inert vegetable fibres soluble, and hastening the decomposition of animal substances, is of the greatest importance in agriculture. Substances may be rendered highly enriching in a short time, which, without it, would have lain long dormant in the soil or the dung-heap. Its effects in this way will be more particularly noticed when we treat of composts.

Wherever there is peaty matter in the soil—which, owing to the tannin principle which it contains, is, by itself, perfectly incapable of putrefaction—lime is the true remedy. On the other hand, in a very stiff clay, chalk or lime will render it much more porous, and admit the influence of the atmosphere; it will correct acidity, and assist the nutritious effects of animal and vegetable manures. Quick-lime spread on a soil abounding in vegetable matter will make it active by dissolving the half-decomposed fibres and converting them into a soluble mucilage: being extremely minutely divided by its property of attracting moisture rapidly, a very small quantity produces an immediate effect. Hence it is generally spread over fallows or clover-leys, which are preparing for wheat-sowing. If it were put on the land long before the seed is sown, it would have lost its chief and immediate power by attracting carbonic acid and returning to the state of carbonate or chalk, and all the expense of burning would be thrown away, except as far as it has thoroughly pulverised it. But frost does this with chalk spread before winter at a much cheaper rate; and a good dressing with chalk will last in the soil, and its effects be preserved, many years after all the lime would have disappeared. It is therefore a matter of mere experiment and calculation whether it be more profitable to put ten waggon-loads of chalk on an acre of stiff clay, or one or two waggon-loads of quick-lime. If the soil be very tenacious, the chalk will probably be the most profitable in the end as well as the cheapest; but for a few crops the lime may appear to have the advantage. Everything depends on situation, and the comparative facility with which lime and chalk can be procured.

On poor sands chalk will be found to produce a greater and more permanent improvement than the same value in lime, which, unless it be mixed with clay or vegetable substances, will not be of great use on such soils. When marl can be procured, or clay and chalk, these will be the best correctives for the porous nature of sand, whether mixed by nature or artificially. But marls are chiefly "amendments," and as such will be noticed separately.

It may however be mentioned here, that experience in the use of lime has varied exceedingly owing to two causes; one of which is that limes vary exceedingly in their qualities, and the other, that crops vary exceedingly in their need of lime. The latter of these particularly points to the use of lime as being directly the food of plants, and thus more influential for one crop than another. On the former we may merely state that analyses of lime from quarries in different parts of the island, show that the quantity of lime present varies from 60 to nearly 100 per cent. And an even more valuable ingredient than lime in certain limestones, namely, phosphate of lime, certainly adds largely to the fertilising influence which certain limestones exhibit. Thus in Connemara, Mr. Whitwell of Kendal has had various limestones analysed, with the following results:

	1.	2.	3.	4.	5.	6.	7.	8.
Phosphate of lime . .	7·16	13·8	3·5	14·8	8·5	8·3	13·7	2·0
Silica	..	46·5	82·3	20·2	2·6	41·4	8·4	44·0
Sulphate of magnesia .	..	3·0	..	..	..	0·9		
Chloride of sodium . .	..	2·0						
Potash . . .	..	5·0	..	..	4·6			
Carbonate of lime . .	..	..	8·0	43·8	49·3	..	74·3	
" magnesia	..	31·8	4·2	21·2	35·0	49·4	3·6	5·0
Moisture . . .	..	..	2·0					

It is plain that differences of this kind must produce very great differences indeed in the fertilising influence of the lime we apply. A limestone containing only 68 per cent. of lime, such as some of them near Dublin, will be of less value than a Durham limestone containing 94 per cent. (just as 68 is less than 94) in respect merely of the effect of the caustic calcareous matters on the soil; but if, apart from this mere carbonate there be present a phosphate in any quantity, an effect of an altogether different and valuable kind must follow its application. The mineral phosphate which, while in the masses of the rock, would be comparatively useless, must, when broken down to powder as by burning and slaking the limestone rock, it becomes, be so laid open to the influence of the solvents of the rain and air, as to act upon the plants like a dressing of bones. Then again, consider the effect of a large quantity of magnesia, which when caustic acts more slowly but more persistently—and you cannot doubt that the composition of the limestone you employ must be looked to for much of the explanation of the results of its application.

But apart from the general influence of lime on the soil, there is to be considered the relation in which it stands to the several crops the farmer cultivates.

Immense differences exist among our agricultural crops as regards the quantity of lime which they contain. Thus the ash of wheat-straw contains 6 per cent. of lime, of barley-straw 8 per cent., of rye-straw 9 per cent., and these crops accordingly do not take more than 10 to 15 lbs. of lime out of an acre by the growth of an ordinary bulk. Bean-straw on the other hand, or rather the ash of bean-straw, contains 21 per cent. of lime, the ash of the pea 55 per cent., of the vetch 38 per cent.—much larger quantities, and so an ordinary crop of beans and peas respectively will take by means of the one 88 lbs., and by the means of the other 190 lbs. of lime from the acre. Both of these crops therefore, on the ground of direct use of the lime for food, require a larger quantity of calcareous matter in the soil.

Take now the case of some of the root crops: we have in turnips, bulb and top respectively, lime to the extent of 11 and 23 per cent. of their ash respectively; in the case of mangold a smaller quantity, namely, 8 and 8 respectively; in the case of the potato, 2 and 17 per cent. respectively; in the case of the carrot, 8 and 32 per cent. respectively; in the case of lucern again, which especially prospers on calcareous soils, one-half of its ash is lime. An examination of the ash analyses of plants shows the composition of the crops which they indicate to tally with agricultural experience as to the character of the soil they prefer. Thus the ash of the lucern contains 50 per cent. of lime, and that of sainfoin 29 per cent. These figures accordingly prove that the influence of lime as a manure does to some extent depend upon its power to supply plants with direct food.

We turn now to the more direct manures—those which really contribute the bulk of those materials towards the growth of plants in which the natural soil and air, the only other sources of nourishment open to them, are deficient.

The first and most important class of manures are the excrements of animals. The peculiar property of earth in absorbing putrid effluvia and removing disagreeable smells, appears an indication of nature to lead us to bury putrid animal substances, of which the excrements and dead carcasses of animals are the most numerous and obvious. It would require no length of experience to show that wherever this is done vegetation is more vigorous. There is therefore another motive for burying dung than merely to get rid of a disagreeable substance. From the most ancient times of which there are any records, the dunging of a field has been an important part of cultivation. The preparing of the dung of animals, so as to render it more efficacious, is a later improvement, and has not yet attained the perfection of which it is capable, unless it be so in China, of which we read wonderful accounts. The fresh dung dropped on the ground, far from improving the herbage where it has fallen, appears to injure it, and render it unfit for cattle to eat; when it gradually disappears, and not till then, the spot is restored to its former verdure. But if the dung be dug into the ground and covered with earth, the fertilising effect will be immediately perceived. This is a sufficient lesson to the husbandman to make him bury the dung as soon as possible. But this not being always practicable, it is collected in heaps until it can be carried to the land prepared for its reception by ploughing or digging. By mixing the straw, which has served as litter to cattle, with their dung, the quantity is increased, and by allowing this mixture to heat and putrefy, a greater quantity of manure is produced. This is probably the history of the dunghill. In the making of a dunghill, experience has taught methods which accord well with what science might have taught. The manure must be soluble before it can be effective; this solubility can only be produced in the more solid portions, such as the straw, by putrefaction, which the dung promotes when duly moistened. The exact moment when it is most advantageous to bury it in the ground, in order to its greatest immediate effect, seems not yet fully decided. Some let the decomposition go on until a great portion of the heap is converted into a black, tough, greasy substance, which, from early association, gives the idea of richness. It is no doubt a powerful manure which acts speedily, but is it the most economical? This may be disputed. A great portion of the substance must have been resolved into gases, which fly off and are lost. The remainder, evidently carbonaceous from its colour, has acquired too much of the appearance of charcoal to be very efficient: and it is only the exuding juice which is immediately fertilising. The most experienced farmers agree, that whenever the brown colour of a dungheap verges towards a black, the dung has lost something of its value, besides the diminution in its bulk by dissipation. The best state in which dung can be carried to the land, for an immediate as well as permanent effect, is when the straw is so rotten that it readily breaks into short pieces, without having entirely lost its form: it should then be of a brown or mahogany colour, uniform throughout the mass. Whenever dung is mentioned by foreign agricultural writers, it is generally understood to be in this state, which in English is called short dung. It must however be admitted that farm practice is more and more sanctioning the doctrine of the chemist, that it is true economy to bury manure as soon as we have it.

Autumn application of fresh dung is found more efficient and economical in the long run than the ordinary wasteful management of the dung in heaps. Nevertheless, as manure is wanted for the land at different seasons, it is of consequence that the dung from the yards and stables should be collected in such heaps, and managed so as to be in the exact state which is thought most advantageous at the time when it is carted on the land. To effect this some attention is required. The oldest portion must have its putrefaction retarded, and the newest accelerated, to bring them both to the same state. This is easily done. If a certain thickness of dung is kept trodden down by the cattle, it will be a long time before it decomposes, nor will it do this without being turned over to expose the under portions to the air. If, on the contrary, it be carried out into a heap in a loose state, and occasionally turned over and moistened when it appears dry, it will heat and be ready in a very short time. When a sufficient quantity of short dung can be carried to a field prepared to receive it, and immediately ploughed in with a shallow furrow, it will soon incorporate with the soil, and afford a succession of soluble matters, which will give regular nourishment to the plants. This is said on the supposition that the soil is in that state when it only requires replenishment, and has a texture favourable to the crops raised upon it. In poor sands or wet clays some modification in the state of the dung may be necessary.

In speaking of dung, we have not said anything of the different kinds of dung produced from different domestic animals. In some cases it may be advantageous to keep these separate: for instance, the dung of cows from that of horses; of cattle feeding on oil-cakes or grain, with or without turnips, and those fed on straw or refuse hay only. Cow-dung, when in a fresh state, is thought best for light soils, and horse-dung for cold heavy soils. But in general a mixture of the dung of all the different animals kept on a farm with all the straw that can be afforded, will give a manure of an average strength, which may be used upon all kinds of land; with this difference, that for light soils it should be more decomposed than for the heavy, and also ploughed in deeper; for the air penetrates the light soil to a greater depth, and sooner acts on the manure. In heavy land the straw, if not so much decomposed, will form cavities to let in the air, and facilitate the disintegration and tilth of the soil. All this is well known to most farmers, but not always strictly attended to. It is better to manure slightly and often than to put on a large quantity at once, except for some particular crops, which require a rich earth and consume much manure, such as potatoes, mangold-wurzel, and Swedish turnips. Any one who has raised the above-mentioned roots with the usual manuring, and drawn them off the land to be consumed elsewhere, will acknowledge that his subsequent corn was far inferior to that which had succeeded beans, tares, or clover, with the same quantity of manure.

One chief use of cattle on an arable farm, besides those which are necessary for the operations of husbandry, is to produce manure for the land. In present times of high priced butcher's meat, cattle will more than repay their food and the expense and risk attending their keep. But even though there were a moderate loss, they must be kept, when manure cannot be purchased; and a portion of the land must be cultivated solely for the maintenance of cattle. In some poor soils one-half of the land is not too much to produce manure sufficient for the other half. The loss, if any, on the cattle must be repaid by the increase of the corn crops. Manure is to a farm what daily food is to an animal; it must be procured at any sacrifice. It is better to let land remain uncultivated in rough pasture, as was once the case with a great part of Britain, and is still the case with extensive tracts on the Continent, than to break it up without having the means of manuring it. A few crops may be obtained at first, but the land is deteriorated for ever after, and what has been obtained from it is dearly paid for.

Various means have been adopted to increase the quantity and efficacy of manure. The simplest is to increase the number of cattle, and husband their manure. It is evident that to let cattle run in loose pastures is a great loss, not only on account of the dung which is dropped, and more than lost, but also the urine, which contains the very essence of manure. In all countries where stall-feeding is practised, the lands are highly manured, and the crops more certain and abundant. With this system is connected a much more economical management of the manure, either by keeping the litter and more solid parts of the dung separate from the urine and liquid parts, which are collected in large reservoirs, and used in the liquid state, or by letting the animal remain loose in a pen or box, into which litter is daily put, so that it accumulates under the animal and absorbs the whole of the solid and liquid excrement. The liquid manure system is not gaining ground in farm practice, and it seems to be generally allowed that the best mode of saving it is in the litter of box-fed cattle; the dung thus formed containing the whole of it, in a form to which the ordinary practice of the farm is already adapted. A word or two must nevertheless be said on the uses of liquid manure.

Notwithstanding some apparently contradictory opinions, it is pretty generally acknowledged by those who have had long experience of its use, that urine and similar animal substances have a more powerful effect on the soil, when they have undergone a certain degree of putrefaction, than when they are used in a fresh state, and that this is produced with the least loss of substance when the liquid has been confined in close vaulted cisterns which admit the external air only partially. On light soils this liquid has a most fertilising effect, if it is used frequently in small portions at a time. On very heavy soils this effect is not so apparent, and for such soils the liquid is accordingly mixed with sand or any light earth before it is applied; or, instead of using it at once upon the land, it is poured over the litter, which has been collected in a heap or in a yard, after having served for the cattle. This litter, having been deprived of the urine which would otherwise have mixed with it, would rot very slowly and produce a very inferior kind of manure, unless it were moistened, and fermentation were excited by pouring the half-putrefied urine over it. It may be objected that if the urine is only collected to moisten the straw which has served as litter, it would be as well to let it be mixed at first, without the trouble of pumping it up and the expense of a cistern to hold it. But we shall soon see that there is a very wide difference. In the common mode of collecting farm-yard dung, the straw is very unequally impregnated with animal matter: at one time it will contain a large portion and run rapidly into fermentation; at another, there will be so little, that it is with difficulty that heat is excited in it. By separating the urine and litter, the straw will go much further, and can be mixed with the urine at the most advantageous time; thus it forms a much richer manure in a smaller compass, from not being so much diluted with water. Should there be a deficiency of straw, earth or sand will supply its place, in as far as soaking up the rich juices; for the addition to the manure from the decomposition of the straw itself is very small in proportion to that which animal juices afford. If the liquid is collected from a stable or a yard where cattle are kept as soon as it is produced, and is carried off into a cistern, there will be a much better and drier bed left for the cattle, especially if the rain be kept off by light shades. When the litter is soiled to a certain degree, it may be removed to a heap in a proper place, where its conversion into rich dung may be effected by the addition of putrefying urine, than which nothing will so soon rot vegetable fibres, if the air be admitted to the heap. The portion which is not wanted for some time may be left to decompose more slowly; and as the time approaches when it is wanted for the land, it may be managed so as to be in that state which experience has shown to be most effective in the improvement of the crops.

There is some appearance of certainty and regularity in this mode of making a dunghill, which there scarcely is in the common practice of accumulating straw, dung, and urine without any regularity in a farm-yard, turning it over when the cattle leave it for the pastures, and carrying so many cart-loads per acre on the land to be manured, without any measure of its comparative strength. One portion is often almost burnt black, and another appears like the fresh litter of the stables, not being even thoroughly soaked with moisture. It is true that good farmers pay more attention to their dung-heaps, and endeavour to carry out the manure in a proper state; but how much more readily would this be accomplished by the help of a large cistern full of the richest animal matter in a state of partial putrefaction. In situations where straw bears a high price, it may be doubtful whether a cistern might not permit a considerable profit to be made by the sale of a portion of the straw, without any diminution of the manure required for the farm, since for light soils the liquid might be used alone, and for stiffer soils it might be mixed into a compost with earth, chalk, and any kind of refuse vegetable matter of less value than straw. It was an opinion expressed by a celebrated agriculturist * to the late Mr. Rham, that he considered the use of straw in dung to be merely as a sponge to hold the liquid animal matter in its pores or tubes. In fact, straw or old thatch merely rotten by long exposure to air and moisture is of little or no value as a manure, although it will sometimes produce good potatoes, by rendering a stiff soil pervious and porous; but, in a light soil, a gallon of urine is worth ten times its weight of rotten straw. This doctrine may appear strange to some agriculturists, but it will bear the test of experiment.

It is well to add here the conclusion to which Dr. Völcker's researches into the composition and management of yard manure have led him. We extract them in an abridged form from his papers in the 'Journal of the Agricultural Society.'

"Perfectly fresh farm-yard manure contains but a small proportion of free ammonia.

"The nitrogen in fresh dung exists principally in the state of insoluble nitrogenised matters.

"The soluble organic and mineral constituents of dung are much more valuable fertilisers than the insoluble. Particular care, therefore, should be bestowed upon the preservation of the liquid excrements of animals, and for the same reason, the manure should be kept in perfectly waterproof pits, of sufficient capacity to render the setting up of dung-heaps in the corner of fields, as much as it is possible, unnecessary. Farm-yard manure, even in quite a fresh state, contains phosphate of lime, which is much more soluble than has hitherto been suspected. The urine of the horse, cow, and pig, does not contain any appreciable quantity of phosphate of lime, whilst the drainings of dung-heaps contain considerable quantities of this valuable fertiliser. The drainings of dung-heaps, partly for this reason, are more valuable than the urine of our domestic animals, and therefore ought to be prevented by all available means from running to waste.

"The most effectual means of preventing loss in fertilising matters is to cart the manure directly on the field whenever circumstances allow this to be done.

"On all soils with a moderate proportion of clay, no fear need be entertained of valuable fertilising substances becoming wasted if the manure cannot be ploughed in at once. Fresh, and even well-rotten dung contains very little free ammonia; and since active fermentation, and with it the further evolution of free ammonia, is stopped by spreading out the manure on the field, valuable volatile manuring matters cannot escape into the air by adopting this plan. As all soils with a moderate proportion of clay possess in a remarkable degree the power of absorbing and retaining manuring matters, none of the saline and soluble organic constituents are thus wasted, even by a heavy fall of rain. It may, indeed, be questioned, whether it is more advisable to plough in the manure at once, or to let it lie for some time on the surface, and so give the rain full opportunity to wash it into the soil.

"It appears to me a matter of the greatest importance to regulate the application of manure to our fields, so that its constituents may become properly diluted and uniformly distributed amongst a large mass of soil. By ploughing in the manure at once, it appears to me, this desirable end cannot be reached so perfectly as by allowing the rain to wash in gradually the manure evenly spread on the surface of the field."

Among other conclusions regarding the common management of dung-heaps to which Dr. Völcker leads us, are the following: During the fermentation of dung, the phosphate of lime which it contains is rendered more soluble than in fresh manure. In the interior and heated portions of manure-heaps, ammonia is given off; but, on passing into the external and colder layers of dung-heaps, the free ammonia is retained in the heap.

Ammonia is not given off from the surface of well compressed dung-heaps, but on turning manure-heaps it is wasted in appreciable quantities. Dung-heaps, for this reason, should not be turned more frequently than absolutely necessary.

If rain is excluded from dung-heaps, or little rain falls at a time, the loss in ammonia is trifling, and no saline matters of course are re-

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* Mr. De Fellenberg, of Hofwyl, near Bern, in Switzerland.

moved; but if much rain falls, especially if in heavy showers, upon the dung-heap, a serious loss in ammonia, soluble organic matter, phosphate of lime, and salts of potash is incurred, and the manure becomes rapidly deteriorated in value, whilst at the same time it is diminished in weight.

The worst method of making manure is to produce it by animals kept in open yards, since a large proportion of valuable fertilising matter is wasted in a short time; and after a lapse of 12 months, at least 2-3rds of the substance of the manure is wasted, and only 1-3rd, inferior in quality to an equal weight of fresh dung, is left behind. The most rational plan of keeping manure in heaps appears to be that adopted by Mr. Lawrence, of Cirencester, and described by him at length in Morton's 'Cyclopædia of Agriculture,'—which consists essentially in adding each day's store to a narrow heap, and covering it with earth at once, completing the heap as you go.

The great use of liquid manure on light soils is to impregnate them with soluble matter, which being diffused through their substance, supplies nourishment to the roots of plants, wherever they may shoot out. It may be applied to the land at any time before the seed is sown, and soon after, when the blade springs up or the seed begins to form; in short, whenever the plant requires fresh nourishment, or when that which existed in the soil is diminished. Without liquid manure, the poor silicious sands of Flanders could never be cultivated, much less produce crops which vie in quantity and quality with those on the best soils. The quantity of farm-yard dung, in a very rotten state, which this soil would require according to the common system of manuring, could never be produced by all the straw which can be raised upon it in its first state of cultivation. But cattle produce urine, and this produces roots for cattle. The great effect of liquid manure has set the farmers on finding some artificial substitute for the simple urine and diluted dung of cattle. Such substitutes are obtained by mixing all kinds of refuse animal matter with water, and inducing putrefaction. The emptyings of privies from towns is scarcely a substitute; for it is the same as the liquid from the stables in a more concentrated form; but the refuse of oil-mills and various manufactures, when diluted and mixed with a portion of putrid urine, soon become assimilated to it. This becomes a branch of trade in those countries where nothing will grow without manure, and is a resource where an increasing population demands the cultivation of inferior soils to supply the necessary increase of food, as well as an increase of produce from those which are naturally fertile.

The increase of manure by the formation of *composts* is well known in many parts of Britain, and by their means the land has in many districts being rendered much more productive. The fundamental principle upon which composts have been made, is that of impregnating portions of earth with those parts of the dung of cattle, which, from want of management in the common dunghills, would have been dissipated and lost; and also accelerating or retarding the decomposition of animal and vegetable substances by the addition of earths, such as chalk, marl, clay, and even sand, according to the nature of the soil on which the compost is to be used. All solid manure which is to be ploughed into the ground should contain certain parts already soluble in water, which promote vegetation: while other portions should be in a progressive state, so as to afford a succession of soluble matter by a gradual and slow decomposition.

Liquid manure, however active and immediately effective, soon loses its power; whereas solid dung, well prepared and ploughed into the ground, will last for several crops. It is the judicious use of both these manures, conjointly, which has the best and most permanent effect. The dung or compost, having been ploughed in well, requires some time before it can have any direct effect on the germination of the seed or the nourishment of the plant. The liquid, on the contrary, acts from the moment it is poured on the surface. It is the milk of the young plant, which thrives upon it and stretches out its fibres through the earth, till it reaches the dung, which is now in a proper state to supply the more vigorous roots with sufficient nourishment. It is evident that the growth must be more rapid and regular, and not so liable to be checked from want of proper nourishment, nor are the young roots in danger of perishing by being too soon exposed to the immediate contact of rank dung. Every exertion should therefore be made by the industrious husbandman to increase the quantity and improve the quality of every species of manure both solid and liquid: and here careful experiment can alone be depended upon.

In the formation of composts the principal objects are, to regulate the decomposition of the organic substances, and to increase the bulk of the manure by means of less expensive materials than straw. For these purposes lime or chalk is generally used: the former, in its caustic state, to accelerate the decomposition of fibrous matter; the latter to add to the mass, and absorb any portion of acid, which is always produced in a certain stage of the fermentation. The mode of doing this is so generally known, that it is needless to describe it: we shall only observe that the stiffest clay may be used with advantage in composts, where better soil is not at hand; and for light lands, the stiffer the clay the better, provided it be thoroughly incorporated with the manure. The most useful material, under proper management, is vegetable soil or turf. This may be laid in layers with quick-lime and earth; the whole being well soaked with liquid manure. If any kind of vegetable matter, such as fern, pond-weeds, &c., can be added, it will be so much the richer. The lime and urine acting decompose and transform it, the woody fibre is dissolved, and the whole mass, when turned over and well mixed, becomes a very rich earth, which, being spread on the land and slightly ploughed or harrowed in, greatly enriches its surface. By this means many poor soils may be improved, where the cultivation is not sufficiently extended to produce straw.

Although bones have been treated of in a separate article [BONES], it may be proper to mention here, that if some easy means of dissolving their substance were discovered, they might be made of much greater use than they now are. At present they are put in with the seed in a broken state, and as they remain a long time undecomposed in the soil, their effect, after the first crop, is scarcely perceptible, unless a very large quantity is used. By mixing dissolved bones in a liquid state with earth, almost all the component parts of urine would be there.

[We leave the preceding sentence as written many years ago by Mr. Rham, that he may have the credit of so early a prediction of the result which has actually followed the discovery of the method here discussed. In the article on BONES, Baron Liebig's method of dissolving them, which is now in universal practice, is described.]

Besides an immense number of waste substances now used in manure, we have, in guano and other imported fertilisers, means of replenishing our soils of which the agriculturists of thirty years ago knew nothing, and to some of them we must now make some reference. But, first, it may be named, that the ashes of vegetable substances which have been burnt are very effective in stimulating vegetation. They are chiefly used as a top-dressing on young clovers and grasses; and wherever there is an appearance of sourness in the grass wood-ashes are of great use. It is however seldom that wood-ashes are used as manure until the greater part af the alkali has been extracted; but when the surface of the land is pared off, and the dry sods are burnt, the ashes which result from this operation are very effective in producing a good crop without any other manure. [PARING AND BURNING.] The refuse ashes from bleachers' and soap-boilers' premises have still some portion of alkali in them, and, as they contain lime and other earths in a very divided state, their effect on the soil is very perceptible. Sea-salt has been extolled and decried at different times, owing probably to the different circumstances under which it has been tried. Mangold-wurzel undoubtedly benefits by its application; and one or two cwts. per acre, in inland situations, will benefit other crops as well. Quick-lime slaked with salt water is a powerful manure.

It is hardly consistent with the character of this Cyclopædia that instruction should be given in extreme detail on the source and supply of the manures of the farm, but the conclusion may be named, that on well-managed land, cultivated on the alternate system of cropping where at least one-half the land grows grain, there will be a supply of from 3 to 4 tons of dung per acre, according to the rotation adopted and certainly not more than 5 tons, even under good management, and heavy crops. But what is wanted under such a rotation? Suppose it to be a six years course of cropping, namely,—1, wheat; 2, beans; 3, wheat; 4, swedes; 5, barley; 6, clover. There are at any rate two crops to which dressings of farm-yard dung are desirable,—namely, beans and swedes; and in England, the clover, also, either before it has yielded its crop or after it, for the wheat often then receives a dressing. In the former case 100 acres, and in the other 150 acres, on a farm of 300, have to receive a dressing of manure. A quantity equal to 1000 tons is all that can be expected, and the 10 tons of dung, which is all that can be given per acre, according to the one system—the 7 or 8 tons per acre, which is all that it provides in the other case—are a very imperfect dressing indeed. What is wanted, in order to a thoroughly liberal treatment of the land? On 50 acres of clover, 500 tons of yard manure are wanted; on 50 acres of beans, 750 tons of yard manure are wanted, besides at least 7½ tons of guano. Over the 50 acres of turnips we want 750 to 1000 tons of farm-yard dung. These quantities amount to 2000 tons of dung,—a quantity which it is useless to expect, seeing that it is double what good management supplies.

Hence the need of artificial assistance to eke out the means which the domestic supplies provide. Till within the last few years the ordinary plan of doing this was by means of compost heaps, in which by the aid of a little farm-yard dung as a ferment, materials less liable to decomposition were induced to rot together; in which, too, the waste products of other processes were economised and turned to use. What a number of things may thus be turned to good account is apparent from the mere list of them:—Animal, vegetable, and mineral substances existing upon the farm; roots, hedge clippings, and fallen leaves; couch grass, fern leaves, moss, river and sea weeds, sods and turf from ditches, lanes, and hedge-rows; saw-dust, spent bark, and peat, when properly decomposed. Many of these contain nitrogenous ingredients in larger proportion than the straw of grain, and several of them are equally rich in the mineral constituents of plants. Animal substances, such as carcasses, blood, bones, fat, blubber, waste fish, sprats, and various shell fish, are, in particular places, to be sometimes had abundantly. They all contain nitrogen, and so are capable of forming ammonia in larger quantity than our highly valued farm-yard dung. Mineral substances also are available: earth from hedges, scourings of ditches, banks, ponds, &c., containing a large share of vegetable matter, and road-scrapings are also elements of composts. Many refuse substances of trade and manufactures are also available in this way: woollen rags, shoddy, soapers' waste, soapers' ley, paper waste, glue refuse, and refuse of salt-works, of starch-works, sugar-works, slaughter-houses, cider-mills, gas-works, &c., may thus all be used. Many of them are not fit for use in their natural state; but in compost with others, and suffered to rot there, they become useful.

Composts, too, are useful as diffusing and diluting stronger applications: guano may thus be economised. They exercise a beneficial influence on fertility, in virtue of their mechanical effects upon the soil. Stiff soils may thus be improved by vegetable composts, and light soils by heavy composts. Lime, of course, is a chief ingredient in composts, and has been already adverted to. Let us, however, call attention to the labour of making and carting bulky and comparatively poor manures, as composts generally are, in order to defend the greater economy as a general rule of purchasing artificial fertilisers, in order to supplement the deficiency of what may be called the natural supply.

What an immense variety of artificials, so-called, which the farmer has now at his command, is apparent from the following list:—

Guano.
Bones.
Superphosphate.
Blood manure.
Wool manure.
Nitrates of soda and potash.
Gypsum.
Salts of various kinds.
Soot and charcoal.

To guano reference has already been made. [GUANO.] It may be applied to almost every crop with advantage, and it is well to mix it with mould for diluting it, or with common salt for preserving it. M. Barral, a well known French agriculturist, "exposed to the air for fifteen days equal weights of guano, and of guano mixed with half its weight of common salt, and he found that pure guano lost 11·6 per cent. of its nitrogen during that time, while that mixed with salt had lost only 5 per cent." And Mr. Northcote's conclusions are, that "agricultural" salt is an energetic absorbent of ammonia, both on account of its chloride of sodium, and on account of the sulphate of lime which it contains; and that the quantity of lime-salt present especially, most powerfully affects its action in this way. Its agency, however, does not seem to be a very permanent one, though it will collect and retain the ammonia long enough, probably, for agricultural purposes.

When thus mixed with a substance, which at the same time that it fixes more or less the volatile ingredient of guano, does also increase the bulk of the manure, and so enable its more even distribution over the land, it should be applied during, or immediately before the season of most rapid growth; as, for instance, if for grass, just after a mowing, when the young plants, furnished with a full grown apparatus of roots are prepared to make rapid use of whatever food for plants is presented to them. For the same reason too, it is best applied to the wheat crop in spring time over the young plant, rather than before the sowing, whether that is spring or autumn. In that case, some 3 or 4 cwt. per acre of the manure properly prepared is sown broad-cast, and hoed or harrowed in, or if, during wet weather, left without a harrowing. For green crops again, as swedes or mangold-wurzel, it is more commonly sown broad-cast over the raised drills, between which, the farm-manure is placed, and then covered by the same splitting of the drills which covers the manure. Or if the seed is sown upon the flat, the guano is mixed with a large quantity of ashes, and either sown broad-cast previous to the harrowing which precedes the sowing machine, or it is drilled under the seed by the same machine—a separate set of weighted coulters being used for its conveyance—the effect being, that the manure is covered by the earth before the seed is deposited above it.

Of all the other artificial fertilisers now available in English agriculture, that which most directly comes in competition with guano is the nitrate of soda, of which it is probable that large supplies may become available, especially from Peru. The nitrates of potash and soda are applied at the rate of about 1 cwt. per acre, and especially on poor lands they wonderfully increase luxuriance of growth in corn crops, and the consequent yield of corn per acre. In several instances 1 cwt. per acre has produced an increase of 12 bushels per acre in the wheat crop, and of 4 or 5 sacks in the oat crop, and though it is especially influential in the case of poor lands, yet that it is also of great service on fertile soils well-managed, is plain from the following statement by Mr. Hope, of Fenton Barns, Haddington:—

He says in a letter to Mr. Pusey, "I have only applied nitrate for two years to wheat, and that after seeing the account of your own experiment in Mr. Caird's 'English Agriculture.' In April, 1852, I top-dressed wheat after potatoes; the soil a dry gravelly loam. At the time the wheat was not very promising in appearance, I sowed on part 1 cwt. nitrate mixed with 1 cwt. salt per imperial acre; on another portion 3 cwt. Peruvian guano was applied, and a part got nothing. The nitrate of soda soon took the lead, and kept it. A portion of each was threshed separately, when they were found to yield as follows, viz:—

PER IMPERIAL ACRE.

	Straw.	Wheat.
1 cwt. nitrate of soda	37¾ cwts.	53 bushels.
3 cwts. guano	36 "	49 "
Nothing	33 "	39 "

"In 1853 I tried the same thing on wheat after beans; I never, however, could detect any difference with the eye, except where the crop got nothing, though in the former year the difference between the two manures could be seen at a glance; and having cut the crop with a reaping machine, which rather intermixed the lots, I was prevented threshing them separately. I have bought 5 tons of nitrate for next year and mean to apply a portion to potatoes."

The only reason why nitrate of soda is preferred to nitrate of potash depends upon the greater cost of the latter. The proper time for sowing either is during the period of rapid growth; they, like all soluble manures, are immediately spread throughout the soil by the showers, and of course are liable to waste unless the plant to which they are applied be ready to use them at once. Both of these salts are liable to adulteration, and common salt is the chief substance used for this purpose; its presence is detected on throwing any of it on some hot coals by the crepitating sound which follows. Pure nitre burns the coal up without any of these little explosions.

We come now to the use of bones as a manure. Raw bones contain perhaps half their weight of phosphate of lime; when burnt they contain perhaps 60 or 65 per cent. of phosphate of lime. It is chiefly for this phosphate that the bone manure is valuable, and as in addition to the greater quantities of phosphate which burnt bones contain, they are also superior as regards the facility with which they can be decomposed, burnt bones are more valuable agriculturally than raw ones. This phosphate exists in the mineral world both as fossils and simply in the mineral form; some of the fossils contain half their weight of phosphate of lime; and apatite, a mineral phosphate imported from Norway and America, contains upwards of 90 per cent. of phosphate of lime. It is, however, in its natural state almost valueless as a manure, owing to its insolubility; and as the agricultural value of bones can be greatly increased by increasing their solubility, so whatever value this mineral phosphate possesses is conferred upon it by the same process.

This process consists in the adoption of means which shall have the effect of reducing the material to a fine state of division. When the phosphate of lime is acted on by sulphuric acid one half the lime is taken forms it by the acid, and so sulphate of lime or gypsum is produced, the other half of the lime in combination with all the phosphoric acid forms what is called super-phosphate, which is characterised by its solubility in water; and although when it becomes mixed with the earth when put on the land, this extra quantity of acid becomes neutralised by the lime or the alumina of the soil, yet having been once decomposed the bone earth retains so exceedingly finely divided a state that rain is able to act upon it as a solvent much more powerfully. The reason why bone-dust is more powerful as a manure than the original bones is, that its finer division gives a larger surface for rain water to act upon, and wash off a portion of its substance as food for plants. Ground and fermented bones are thus more immediate in their action. For further remarks on the use of bones and guano we refer to articles on those subjects. It is to them that we mainly look in this country for the means of supplementing the natural supply of manure on the farm.

It is not worth while going into any detail regarding the particular fitness of other special manures. In practice no reader is likely to go into the manure market for sulphate of magnesia and soda, nor even for silicates of potash and of soda; though these are said to be directly useful in strengthening straw. If the farmer can get a supply of guano, bone dust, superphosphate, and nitrate of soda, to supplement farmyard dung, he is not likely to go further.

As to the value of special mixtures of different salts on manure, certainly the fancy for that kind of thing ran wild some years ago, but the relative values of manures are becoming now better understood. It is, however, right that we should say a word on soot as a manure. It is used everywhere with good effect in virtue of the gypsum which it contains, and in virtue of the small quantity of ammoniacal salt which it retains as driven off from the coal. Thirty bushels per acre are a common dressing for grass; and for potatoes it has been long known as a useful manure.

Leaving now the subject of auxiliary manures—which has latterly become one of the most important in the whole range of English agriculture—we recur once more in conclusion to the ordinary farm practice connected with the annual replenishment of the soil. Farm buildings should be so made as to remove all the water which falls upon the roofs, that it may not dilute the manure made in the yards. Their yards if any are open should be small and partly covered. Arrangements for feeding in boxes where all the excrement is absorbed by the litter are to be preferred; and where yard-manure is made, or stall-fed cattle have to be daily cleaned out, the manure thus daily made should be daily removed to heaps made on Mr. Lawrence's plan, to which reference has already been made.

One word further may be allowed on the practice of folding sheep on land, and of top dressing clover and grass lands; the policy of that practice has been remarkably justified by the researches of Dr. Völcker, to which allusion has been made. Hitherto the wastefulness of top dressing has been admitted universally, and the practice has been regarded as one of the unfortunate circumstances connected with the plant so treated, which could not be avoided. Both top dressing and folding, however, which latter has all along been distinguished by the fertility it conferred, may be now regarded as practices which, if rightly performed, are not more wasteful than other modes of applying manure. It is becoming more and more the practice in England to apply the bulk of the farm-manure in this way. Clover, either immediately after the barley harvest, or during that autumn, receives a dressing of 10 to 15 tons of farm-yard dung, which as it has been made during the previous spring, is generally in a very well rotted state; or the same clover receives a heavy dressing in the subsequent autumn, previous to being ploughed up for wheat. The former is considered the best plan, at least as regards that portion of the clover which is to be mown in the following year. The turnip crop is thus being left more and more dependent on the use of artificial manure—a half-dressing of dung and a good dressing of superphosphate of lime is found equal in effect to the best whole dressing of dung which under other management the farm could afford.

One word on the practice of folding sheep on land in the case of light soils. It will no doubt be a permanent practice. Probably a larger portion however of the green crop break is being harvested and carried home to yards, for fatting stock to help convert the straw into dung, and to help, along with the consumption of clover, hay, and cake and corn, to make much better dung than has hitherto in general been made. Probably on a light-land farm in Norfolk, one-third of the turnip-crop will be carried home, leaving two-thirds on the land for sheep. On the best managed lands there, every sheep will consume 1 cwt. of cake or corn, in addition to the 12th part of an acre of swedes, and if in doing that it increases 10 or 12 pounds a quarter, as it probably may, it will do little more than simply return in its excrements all the green food which it has consumed. That turnip crop had built up its bulky structure at the expense of the deeper as well as of the shallower soil (for we have traced the roots of turnips 4 feet downwards), and largely also out of the material which it has gathered from the air; and by means of the sheep this large quantity of plant food, gathered from subsoil and from air, is all accumulated in the upper soil, greatly of course to its advantage, and greatly to the advantage of the subsequent wheat crop, and of such plants as, like it, may be more exclusively dependent than the turnip is upon the material which the surface soil contains. The material thus lodged upon the soil is in a form in which it is more liable to putrefaction and waste than it was: but air washes these fugitive ingredients into the land, and the plough soon covers all up; and when the mechanical structure of the land is such as to benefit by the treading of the animals thus fed, there is no operation in the whole range of farm practice which at once adds such an increased fertility to the soil.

MANURING, in horticulture, requires to be considered in a somewhat different light from that process as applied to agricultural purposes. This is necessary because of the variety of plants, possessing different constitutional habits, to which the gardener is required to turn his attention, and also because of the different results which are expected in horticulture and agriculture. In preparing the present article, the writer has confined himself to simple practical facts, and has adverted only occasionally to chemical explanations.

The gardener is called upon to cultivate species from almost every kind of soil on the surface of the globe, intermediate between the shifting sands of the desert and the most fertile alluvial land continually enriched by the decay of vegetable and animal substances. It is therefore obvious that considerable caution is requisite in applying manure, and in determining the quantity or quality suited to the respective constitutions of the various subjects which the horticulturist takes under his care. Thus, although many plants can scarcely receive too much manure, others, such as the resinous trees, may be actually killed by it.

The kind of manure chiefly used, and frequently the only kind procurable by the gardener, is that derived from the farm-yard, consisting chiefly of the dung of horses or of horned cattle, more or less mixed with litter. Formerly it was very generally the custom to take advantage of the heat resulting from the fermentation of such dung in hot-bed forcing, and there are still some objects for which this kind is found preferable [HOT-BED]; but since the hot-water system of heating has received so many improvements, the continued fermentation and consequent degree of decomposition which dung undergoes in hot-beds is rendered a less important means of obtaining artificial warmth, and consequently it becomes the more important to inquire whether manure is most beneficially applied in a state of decomposition, as some have advocated, or in a state as recent as possible, no fermentation being permitted previous to its deposition in the soil.

If dung contains a large proportion of litter, and particularly if the latter be in a dry state, it will be advisable to subject it in nearly all cases to a moderate degree of fermentation, assisted by a sufficient quantity of moisture, in order that the fibre of the straw may be reduced to a state permeable by the spongioles of plants, and either become sufficiently dissolved for affording nourishment itself, or serve in the first instance as an absorbent reservoir for substances of still greater solubility. Where such preparation has not been attended to, litter has been frequently observed, when turned out of the ground after a dry summer, to be still in a dry musty state, having evidently been of little benefit to the crop; and in the case of many plants, which require much manure, litter in this state would actually prove very injurious. But if the dung be what is termed short, containing little straw, and that well saturated with the liquid proceeds of the stalls, it may be dug in without fermentation for most kitchen-garden crops, provided it is well divided and properly mixed with the soil in digging or trenching in. This is necessary in all cases, but more especially so when the manure is applied fresh; for disease is often induced by the roots entering into masses constituted of particular substances which either wholly or, at all events, too powerfully predominate over the proper nutritive solutions.

But, on the other hand, if the soil is of a wet and stiff nature, then long unrotted dung is most proper, because its straws form so many minute drains, which, to speak technically, keep the ground open; and in such soils, by means of littery manure and drilling, a crop of potatoes, for example, can be raised very superior in quantity and quality to that obtained from the application of rotten dung. In this case the previous reduction of the fibre of the straw is not requisite; for the moisture of such soils is sufficient to effect this by degrees, and whilst the process of growth is going on. The authority of Miller may be adduced on this subject; in his 'Gardener's Dictionary,' he observes, "In very cold moist land, I have frequently seen new horse-dung buried as it came from the stables, and always observed that the crops have succeeded better than where the ground was dressed with very rotten dung."

On the other hand, dung that has been moderately fermented, and frequently turned over, so as to be easily cut with a spade, is the most proper for such trees as require manure, or for slow-growing crops, where the roots have to remain for years in contact with it. With regard to trees and many perennial plants, no more injury would be incurred by using fresh dung instead of rotten, for the first season, or rather whilst vegetation continued active; but after the roots become nearly dormant, canker or disease of some sort is apt to ensue. The roots may have grown luxuriantly during the summer; but when they are arrested by the approach of winter, decomposition will still be going on amongst the materials on which they feed, and these materials may perhaps be chemically changed, before the roots are again called to action.

These remarks relate chiefly to the description of manure which is most generally used. Other substances which are or may be successfully applied to promote the growth of vegetation are exceedingly numerous. [MANURE.]

Animal substances are very powerful manures, and require to be attenuated or diluted before plants can derive nourishment from them, or in fact before either roots or tops can be safely brought within their contact. If the roots of a plant be wholly immersed in oil or in blood, that plant will be destroyed. Blood is one of those liquid manures which is occasionally supplied to plants so situated as to render bulky manure inapplicable; but it should unquestionably be copiously diluted with water, and be allowed to rot in compost. Bones are another form of animal matter much employed, and of considerable energy, especially in calcareous soils, provided they are reduced into small fragments and fermented before being used. Gardeners often use them in that state; and now, as dissolved in sulphuric acid, they are, of course, as available in the garden as in the field.

The liquid portions of excrementitious manure likewise require either to be diluted with water or to receive an admixture of soil before they are brought in contact with the roots of plants. In the case of trees with roots lying deep in the ground, such dilution is not always necessary; but, generally speaking, adherence to the rule is advisable.

Flesh, or the carcases of dead animals, should be chopped up and covered and mixed, with many times their bulk of soil and with some lime. This, when turned over, will still form a very strong manure, and for some plants much too strong; but for such as the vine it will form a valuable compost, particularly if broken bones are added to it.

Manures derived from the vegetable kingdom require little preparation if they consist of succulent plants; their substance is easily soluble, and they may therefore be turned fresh into the soil. The period of their growth when this is most beneficially performed is before they run to seed. Weeds may even be used with great advantage, if properly prepared; but bad consequences may result from their seeds rendering the ground foul, and thus occasioning much expenditure of labour to extirpate them again. Seeds, it is well known, will not germinate without air; but with this, and sufficient heat and moisture, nothing can prevent them from germinating. Therefore if weeds be thrown into a heap and turned, whilst at the same time fermentation is encouraged till the heat is fully equal to that which would naturally cause the germination of the seeds, taking care that the outside be turned into the centre, no danger will arise from using such manure after the process has been continued sufficiently long for the germination of the slowest vegetating seeds which the heap may contain, because under these circumstances the young plants will be continually perishing, as the heap is turned over from week to week. There are many aquatic plants that will not grow on dry ground, and a preparation similar to the above is not essential for the purpose of killing their seeds before their application to dry ground, which is not, so to speak, their proper element.

Woody fibre unfermented is useless as a manure; and tanner's spent bark, a substance very absorbent and retentive of moisture, is not capable of affording nourishment, until the tannin is got rid of by fermentation, when plants, as may be observed in bark-beds, root very readily in tan. Inert peaty matter is a substance of the same kind, and will remain for years exposed to air and water without undergoing change. When peat becomes inert, it is in vain to attempt to grow any sort of plant in it; but nothing is more certain than that if drained of stagnant moisture and mixed with lime and dung, it will become very fertile for most crops. It often happens that peat or *bog-mould*, frequently procured at a great expense for American plants, becomes inert; in such cases, a good result would be obtained by turning out the peat and mixing it up in a heap with a quantity of leaves or fresh litter sufficient to promote a moderate degree of fermentation; then, as in the case of tan, it will afford nourishment, and will, from a state of uselessness, become valuable.

Of mineral manures *lime* is the most useful. It is not recommended for soils that contain a large proportion of soluble vegetable matter; but it produces excellent effects in such as abound in inert vegetable fibre. Gypsum, which is found in the ashes of grasses, proves a manure for lawns.

Common salt is sometimes employed in minute portions; especially in combination with vegetable matter, in the instance of sea-weeds, in which case it is found of good quality for fruit-trees and kitchen-garden crops; but vegetable life is certainly destroyed by it, if applied in any considerable quantity. Exceptions may be noticed in the case of marine plants; the samphire for example, requires it when cultivated in inland districts; and this is also true of the vegetable inhabitants of the great salt plains of Asia. Wood-ashes, which consist principally of vegetable alkali united to carbonic acid, are a good manure, but of short duration, and they leave peaty soil in a worse state than before their application. The application of dung and lime, of composts of clay, marl, scourings of ditches, &c., would render peat *permanently* fertile, more especially when draining is judiciously attended to.

MANUSCRIPTS. [Palæography.]

MAP (Latin, *mappa*, a napkin; French, *mappemonde*, a map of the world). A map is a representation of the surface of a sphere, or a portion of a sphere, on a plane. The name, however, is commonly applied to those plane drawings which represent the form, extent, position, and other particulars of the various countries of the earth.

Maps, or delineations resembling them, we may reasonably conclude were coeval with the earliest geographic knowledge; but it is not possible to fix the time of the first attempts to construct maps. The geographical knowledge of the Greeks, as exhibited in the Homeric poems, comprehended only a small part of Europe, Asia, and Africa, and there is not the slightest allusion in them to any mode of delineating or representing the surface of a country. In their maritime adventures the Greeks are said to have been assisted by the nautical maps of the Phœnicians; but however this may be, we have no account of anything deserving the name of maps before those of Anaximander the Milesian, who is alleged to have been the first to construct a map of the world. Itinerary maps of the places of encampment were almost indispensable to the commanders of armies; Diognetus and Beton are mentioned (Pliny, 'Nat. Hist.' vi., 17) as the surveyors of the marches of Alexander, who was very careful in examining the measures of his surveyors, and in obtaining his descriptions from the most skilful persons. The science of geography made rapid advances under Eratosthenes [Eratosthenes, in Biog. Div.; Geography], who had the great merit of reducing geography to a regular system, and of founding it upon solid principles. He introduced into his map a regular parallel of latitude, which he accomplished by tracing a line over certain places whose longest day was observed to be of the same length. This parallel extended from the Strait of Gibraltar to the mountains of India, passing through the island of Rhodes; and from its central position with respect to the principal ancient nations, it became a standard of reference in the maps of this period. Succeeding geographers made many attempts to determine the longitude of places by measurements of this line, but with no great success. Eratosthenes, in addition to the parallel above mentioned and other parallels, undertook to draw a meridian from Meroe through Syene to Alexandria ('Strabo,' ii. 114), and also to determine the earth's circumference by the actual measurement of a portion of one of its great circles. These discoveries and improvements very materially affected the dimensions of all the ancient maps; and from this time the connection between astronomy and geography was so far established as to ensure an advantage to the latter by every advance of the former. This was eminently the case in the discoveries of Hipparchus, who fixed the construction of maps on a mathematical basis, and enabled the geographer to lay down his latitudes and longitudes upon certain principles.

To Strabo we are chiefly indebted for our information respecting the state of geography in the Augustan age. But the extent of the earth's surface known to this writer does not very much exceed that which was known to Herodotus four centuries earlier. His map of the world exhibits some remarkable errors. He supposed the Pyrenees to run north and south; cuts off the projecting province of Brittany from France, places Ireland not to the west but to the north of Britain, and makes the Caspian communicate with the northern ocean though Herodotus had accurately described it as a lake.

The Roman Itineraries show that their surveys were made with considerable care, although there are no traces of mathematical geography in those which have been handed down to us, the chief object in view being the clear direction of the march of their armies. All the provinces of the Roman empire had been surveyed when Ptolemy composed his system of geography, which has happily been preserved to us. It is not so much to his more perfect acquaintance with the earth that Ptolemy owes his reputation as a geographer, as to his giving solidity and unity to the science by fixing its unconnected details on a mathematical basis and carrying into full practice and to greater perfection the system of latitudes and longitudes of Hipparchus, whose invention had been much neglected for upwards of 250 years.

It seems not improbable that the maps found in the MSS. of Ptolemy are really copies of, or derived from, original maps constructed by him or under his care. [Agathodæmon, in Biog. Div.]

The geography of the Arabians is but imperfectly known. Their most eminent geographer Edrisi or Eldrisi, who lived about the middle of the 12th century, divided the world into seven climates from the equator northward, and each climate was again divided into eleven equal parts, from the western coast of Africa to the eastern coast of Asia, the inconvenience of which arrangement is very obvious.

Towards the middle of the 17th century several astronomers undertook to observe eclipses of the moon, with a view of correcting the errors in the longitude of places. These observations, however, were so discordant as to lead to no satisfactory result. Galileo. by the discovery of the eclipses of the satellites of Jupiter, introduced a more certain method, which was rendered available by means of the simultaneous observations of Picard and Cassini at the observatories of Uraniburg and Paris.

Picard and De Lahire were then immediately employed in correcting the map of France, and from this period our maps have rapidly improved. The great perfection to which timekeepers have been brought, and the obvious application of these machines to the determination of the longitude, have greatly contributed to their accuracy. But notwithstanding the advanced state of our astronomical and geographical knowledge, and the science and skill displayed in our great national and other surveys, we may, with Dr. Blair, regard maps as works in progress—always unfinished, and still waiting the corrections to be supplied by the science and enterprise of succeeding ages.

Having thus briefly sketched the progress of map-making, we proceed to give a general outline of the application and construction of maps.

On the Nature and Construction of Maps.—Maps, being plane representations of the surface of a sphere, may be obviously applied to various purposes; hence we not only have terrestrial maps to represent the surface of the earth, but celestial or astronomical maps to represent the sphere of the heavens; and these general distinctions have again their subdivisions.

There are two kinds of terrestrial maps—geographic or land maps, and hydrographic or sea maps: we shall confine our attention principally to the former; the latter, which are usually called charts, having been already described. [Chart.]

Geographic maps, as already noticed, are those which represent the forms and dimensions of the several parts of the earth, with their relative situations and the positions of the cities, mountains, rivers, &c., comprised within their limits. They may comprehend the whole earth, or one of its larger divisions, or a single district, and are called maps of the world, general maps, or particular maps accordingly. If they give the nature of the ground, the roads, buildings, &c., in detail, they become topographic maps, which, necessarily embracing a very small extent of country, are not usually referred to any spherical projection, but are represented as geometric planes, the objects in them occupying the positions severally assigned to them by the trigonometrical operations of the survey. The same distinction is made in charts of small bays and harbours. In either of these cases they are called plans.

When maps of the earth are made to illustrate any of the sciences, they are distinguished from geographic maps, properly so called, and bear their own peculiar names, as geological, or mineralogical, or botanical maps. A collection of such maps is called a physical atlas: such are the admirable atlases published by Berghaus, Johnston, and Petermann, in which the results of the investigations in geology, geography, hydrography, magnetism, meteorology, &c., are presented distinctly to the eye.

Of late years the leading governments of Europe have published maps showing, on a comparatively large scale, the results of elaborate trigonometrical surveys of the several countries: the maps of Austria and France are beautiful examples. In England, the results of the Ordnance Survey of a large portion of Great Britain and Ireland have been published in a series of admirable maps, at an extremely moderate price. The chief drawback is that, in the long intervals between the publication of the different portions, material alterations are taking place with extraordinary rapidity. New railways are made; old roads are stopped up, and new ones opened; new towns spring up round railway stations, and villages become towns. Perhaps no mode of publication could be adopted to keep pace with these changes; and the plates are amended by laying down the new lines of railway whenever they are reprinted.

On some of these government and other large maps of recent production contour-lines have been adopted in the place of shading, to indicate the heights of mountains. A good example of the application of contour-lines is afforded by the large-scale Ordnance maps of Ireland. On the other hand, the Ordnance maps of Wales, and generally the later inch-to-the-mile maps of the British survey, afford very beautiful illustrations of the plan of graduated shading to a carefully considered scale for orological delineations. But much yet remains to be accomplished, at least in ordinary maps, for the delineation of the true forms of mountains, the varying features of valleys, and, in fact, the general configuration of the surface of a country.

Of late, also, relief- or model-maps have been published, which show the orological and other physical features of countries and districts, by producing the various elevations in bold relief of proportionate heights, by means of pressure upon softened and specially prepared paper. Some beautiful specimens have been produced; but, when executed with accuracy, the process is too costly to come into general use.

From the spherical form of the earth, it is obvious that the divisions and varieties of its surface may be most simply and most accurately represented by means of a globe; and, in order to obtain a correct notion of its general geographic features, there is no mode of representation so satisfactory. Large globes, however, are expensive and inconvenient instruments, and small ones, by not admitting sufficient detail, are for most geographic purposes entirely useless. Hence we see the eminent utility of maps, notwithstanding the imperfections which necessarily accompany such a mode of representation; for a spherical surface can by no contrivance be extended into a plane without a distortion of some of its parts.

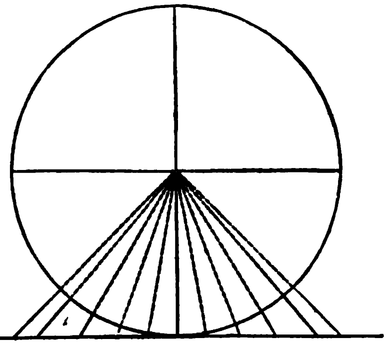
The methods adopted in the construction of maps are as various as the taste and judgment of geographers themselves, but they may all be referred to two principles—namely, *projection* and *development*.

By *projection* is meant the representation of the surface of a sphere on a plane, according to the laws of perspective. By *development* is to be understood the unfolding or spreading out of the spherical surface on a plane. This, however, first supposes the sphere to be converted into a cone or a cylinder,—these being the forms, portions of which most resemble portions of a sphere, and which at the same time are susceptible of the required development.

We shall notice these two principles very briefly, as their mathematical investigation more properly belongs to the article PROJECTION.

There are four methods of spheric projection in general use,—the *gnomonic* or *central*, the *orthographic*, the *stereographic*, and the *globular*, —distinguished from each other by the different positions of the projecting point in which the eye is supposed to be placed.

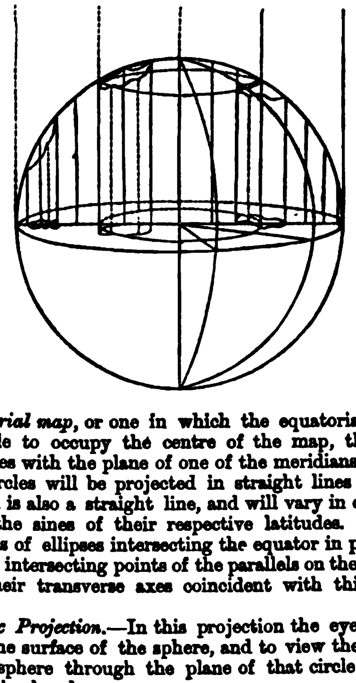
The *gnomonic* or *central projection* supposes the eye to be placed in the centre of the sphere, and that the various objects to be delineated are transferred from the sphere to a plane, which is a tangent to its surface. The entire hemisphere can never be represented by this projection, since the circumference which terminates it is on a level with the eye, and is therefore parallel to the plane of projection. This method is chiefly used in dialling, but may be advantageously applied to maps of a limited extent, more especially if they are maps of the polar regions of the globe. In this case the meridians will be straight lines radiating from the centre, and the parallels of latitude concentric circles, whose distances from the centre will respectively be equal to the cotangents of their latitudes.



In the other cases of this projection, where the perspective plane is parallel to the horizon, or to any meridian, the construction is rendered troublesome on account of the parallels of latitude becoming curves of difficult delineation: these cases therefore are seldom brought into use.

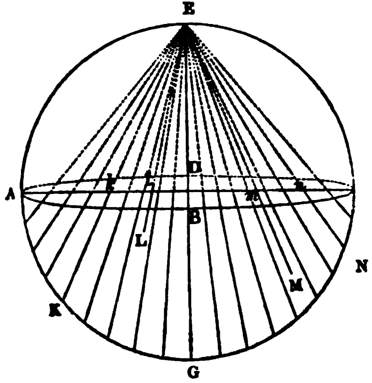
Orthographic Projection.—In this projection the eye is supposed to be at an infinite distance, so that the visual rays leave the sphere in parallel lines. The perspective plane on which a hemisphere is supposed to be delineated is the plane of that diameter which is perpendicular to the visual rays: hence every point of the hemisphere is transferred to this plane by perpendiculars let fall upon it. It will be immediately seen from the figure, that the representation will decrease in accuracy with the increase of distance from the centre; the parts near the circumference being much foreshortened and distorted.

In a *polar map* of this projection, the meridians, as in the gnomonic maps, will be radii, and the parallels concentric circles; these circles, however, will have their distance from the centre equal to the cosines, and not to the cotangents of their respective latitudes.



In an *equatorial map*, or one in which the equatorial regions of the globe are made to occupy the centre of the map, the plane of projection coincides with the plane of one of the meridians. In this case the latitude circles will be projected in straight lines parallel to the equator, which is also a straight line, and will vary in distance from it according to the sines of their respective latitudes. The meridians will be portions of ellipses intersecting the equator in points similar in position to the intersecting points of the parallels on the polar diameter, and having their transverse axes coincident with this diameter and equal to it.

Stereographic Projection.—In this projection the eye is supposed to be placed at the surface of the sphere, and to view the concave of the opposite hemisphere through the plane of that circle, in the pole of which the eye is placed.



If E be the eye, and A, G, C the hemisphere to be represented, A, B, C, D will be the plane of projection; and the position on this plane of any point of the spherical surface will be indicated by a line drawn from that point through the plane to the eye. Thus the points K, L, M, N on the sphere will be transferred to the plane at *k*, *l*, *m*, *n*.

The advantages offered by this method of projection have brought it more into use than the methods before mentioned. It is especially calculated for maps of the world, as usually made in two hemispheres, from the circumstance of the representation being less distorted, and also on account of the meridians and parallels intersecting each other at right angles, as they do on the globe. Its construction also is less difficult than others, since all the great circles of the sphere are either circles or straight lines in the projection. The meridian of 20° W. is the one usually selected by English geographers for the plane of projection in these maps of the world, because this meridian passes very nearly between the eastern and western continents, which therefore occupy their respective hemispheres.

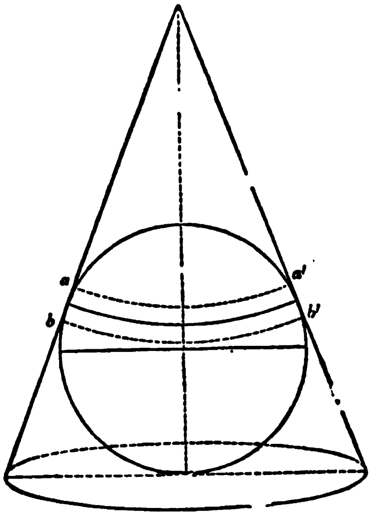
Globular Projection.—This projection, which is a modification of the Stereographic, was invented by the astronomer De Lahire, who supposed the eye to be placed at a distance from the sphere equal to the sine of 45°; that is, if the diameter of the sphere be equal to 200, the distance of the eye from the nearest point of the circumference would be $70\frac{1}{10}$. Some further modification was subsequently deemed desirable, in order that the meridians might intersect the equator at equal distances. This condition is very nearly fulfilled when the distance of the eye is $59\frac{1}{3}$, the diameter being 200 as before.

This projection is also much used in maps of the world, but to simplify their construction, the meridians and parallels are projected into circular instead of elliptical arcs, the deviation from the strict law of the projection being too slight to affect the practical utility of the map.

Of Projection by Development.

The developments to be mentioned are two—the *Conical* and *Cylindrical*.

Conical Projection.—In this projection the sphere is supposed to be circumscribed by a cone, which touches the sphere at the circle intended to represent the middle parallel of the map. If the points on the sphere be now projected on the cone by lines drawn from the centre, it is clear that in a zone extending but a short distance on each side the middle parallel, as the zone $a\,a'\,b\,b'$, the points on the cone would very nearly coincide in position with the corresponding points on the sphere. All the delineations having been thus made, the cone is then conceived to be unrolled, or developed on a plane surface.



Should the map be made to extend much above or below the middle parallel, the distant parts will be very much distorted. To remedy the defects of this projection, various modifications have been suggested, among which those of Flamsteed are generally held in the highest estimation. [CONIC PROJECTION.]

Cylindrical Projection.—From what has been said of the cone, it will be easily understood that a cylinder may be applied to the sphere in a similar manner, and that a zone of very limited extent in latitude may, without very material error, be developed on a cylinder. The peculiarity of this method is, that the meridians, as well as the latitude circles, are projected in parallel straight lines; a condition of the map which makes it very applicable to nautical purposes, and on which (partly) is founded the very ingenious method called *Mercator's Projection*, which is now so universally adopted in our charts, and which, in conclusion, we will briefly describe.

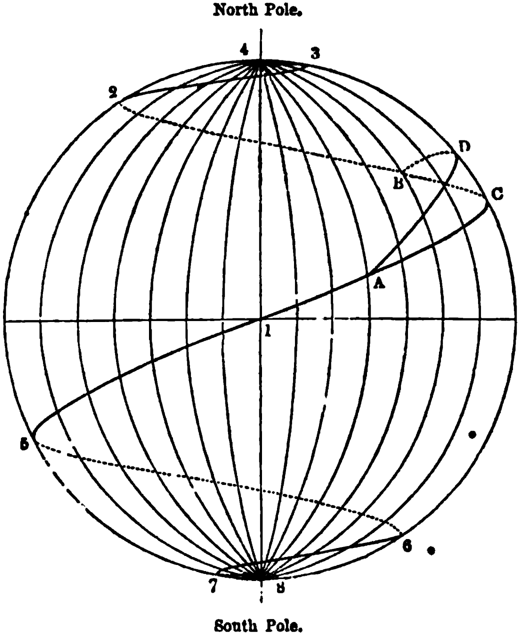
Mercator's Projection.—The line on which a ship sails, when directing her course obliquely to the meridian, is on the globe a spiral, since it cuts all the meridians through which it passes at equal angles. This circumstance, combined with others, rendered a map constructed on the principles of the spherical projections very inadequate to the wants of the navigator. Mercator considered, very justly, that mariners do not employ maps to know the true figures of countries, so much as to determine the course they shall steer, and the bearing and distance of those points or places which lie near their track; and this projection is the result of his efforts to secure to the seaman these desirable ends. The merit of this most useful method is thought by many to be more justly due to Wright; for although Mercator published his first chart in 1556, he omitted to declare the principles on which he proceeded, and his degrees of latitude did not preserve a just proportion in their increase towards the poles. Wright, in 1599, corrected these errors, and explained the principles of his improved construction, in which the degrees of latitude on the chart were made to increase towards the poles, in the same ratio as they decrease on the globe; by which means the course which a ship steers by the mariner's compass becomes on the chart a straight line; the various regions of the map, however distorted, preserve their true relative bearing, and the distances between them can be accurately measured.

The use of this projection constitutes the principal difference between the methods of travelling by land and by sea, and perhaps there is no point of navigation on which a person who is neither a seaman nor a mathematician has so little chance of gaining any information from popular works.

We shall suppose the ship a mathematical point in comparison with the earth, and imagine the whole of the latter to be covered by sea. Also let the ship be always sailing before the wind, and no allowance for leeway or currents be necessary. Throw out also the variation of the compass, that is, suppose the needle always to point due north.

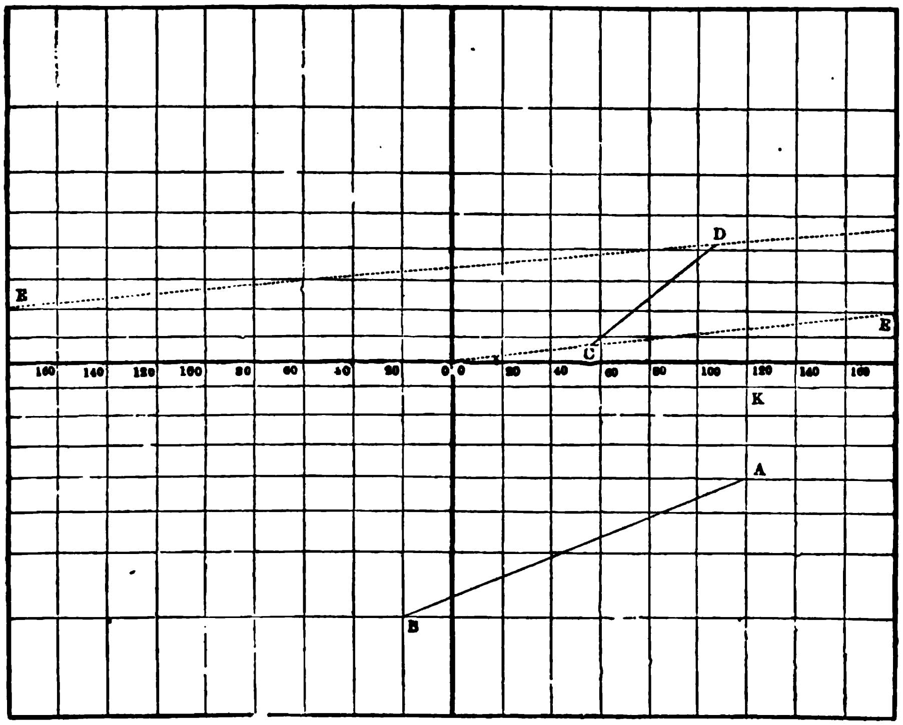
A ship thus circumstanced, if it should continue sailing due north, would in time reach the north pole on a meridian circle of the sphere, on which, if it still kept its course, it would proceed due south, and would at last reach the south pole: such a ship would never change its longitude, except at the moment of passing either pole, when the longitude would alter at once by 180 degrees. If however the vessel sailed continually due east or due west, it would sail upon a small circle of the sphere, being always at the same distance from the pole, and always in the same latitude. In the first case the differences of latitude would give the distances sailed over, at the rate of 60 nautical miles to a degree; in the second case, the differences of longitude, reduced in the same way, and the results multiplied by the cosine of the latitude, would serve the same purpose.

But suppose that the vessel took an intermediate course, say north-east. It would not sail on any circle of the sphere, great or small; for by hypothesis the line of the course is always making an angle of 45 degrees with the meridian; and there is no circle (unless it be the meridian itself, or a parallel of latitude, the equator included) which always makes the same angle with the meridian. Neither could the vessel, keeping such a course, reach the pole; for at the moment when it touches the pole, it is sailing north, whereas by hypothesis it is always sailing north-east. The fact is, that a curve which makes equal angles with all meridians must be a spiral which approaches the pole, encircling it with an infinite number of folds, but never actually reaching it, as in the following diagram, in which the curve 1, C, 2, 3, 4, &c., is that on which a ship would sail from 1 towards the north pole on a course east-north-east, and the curve 1, 5, 6, 7, 8, &c., is that of a course west-south-west towards the south pole. The dotted part of the figure is supposed to be on the other, or the invisible, side of the sphere. A ship sailing from A to B over A C B, keeps one course; but were it to sail over the great circle A D B, the course must be perpetually altering.



The spiral A C B is the only one on which a ship should sail directly from A to B, though there is an infinite number of such curves which pass through both A and B, the reason being, that in every other spiral except A B one or more complete circuits in longitude must be made, and the ship would come again to the meridian passing through A before it reaches B. In the same manner a spiral might be found, passing through A and B, which cuts the meridian of A five hundred times before it passes through B. Of course the shortest course is always preferred; and it is the object of Mercator's projection to lay down such a map of the world, that the straight line joining two points shall be the map of the course which must be followed in order to sail from one to the other in the most direct manner, consistently with always keeping the same point of the compass.

The spirals above described are called loxodromic spirals, or rhumb lines, and under the latter term their mathematical properties are explained. Our present object is to turn the globe into one of Mercator's maps, in a manner which will give the unmathematical reader some idea of its construction. For this purpose suppose the map of the world to be painted on the globe, and let the globe be made of a thin and very elastic material. Let the elasticity of this material increase as we go towards either pole, and so rapidly that it becomes as great as we please at and near the poles. Let the equator E Q be immoveably connected with the internal centre (supposed fixed) of the globe. If then the north and south poles be pulled away from the equator, the thin membrane of the sphere will be extended; and if the pull be continued until the poles are sufficiently distant, a large portion of the sphere on each side of the equator will assume a cylindrical form, or one nearly cylindrical; and the greater elasticity of the upper parts will cause the small folds of the different spirals to be much more extended than the larger ones, so as to become equal to them. Let the mathematical hypothesis implied in the preceding be carried to its extreme limit, that is, let the poles be pulled to an infinite distance; and let the law of the elasticity be such, that the several loxodromic spirals shall have precisely similar successive folds on the resulting cylinder, that is, let them take a regular screw-like form. The meridians will then all become straight lines parallel to one another; and if the membrane be then fixed in its cylindrical shape, that is, if it lose its elasticity, and if one of the meridians be slit all the way down, and the cylinder unrolled into a plane, we shall have before us Mercator's projection, as shown in the following diagram. The degrees of longitude remain everywhere the same those of latitude increase sensibly. The map goes up to 80° of latitude, and any part of the remaining 10° might be drawn; but no space would be sufficient for the whole of the remainder. Any two points A and B, being given, the line A B joining them points out, on the supposition that all the meridians look towards the north, the most direct course on which a ship can sail from one to the other: if a compass were placed at A, then A B would show, A K being the north direction, the point of the compass on which to steer. Again, from C to D the most direct course is on the dark line C D; but C E. E D, is another way of coming to the same point. It must be remembered that the extreme lines on the right and left represent the same meridian, as they coincided before the cylinder was divided for the purpose of being unrolled.



It thus appears that we have a map on which the sailing course between any two places is found by simply drawing a right line. Another advantage, depending upon the nature of the rhumb line however, and not on the projection, is the simplicity of the rule by which the distance sailed can be determined. This is pointed out in RHUMB-LINE.

The preceding is Mercator's projection of the whole 360 degrees of longitude up to 80 degrees of latitude. A chart, as in other cases, is a part of the projection, enlarged to a convenient size.

MAPLE: ECONOMICAL USES. The maple is a very useful tree for industrial purposes, especially in America. Of the sugar-maple it is calculated that there are ten millions of acres in the states of New York and Pennsylvania alone. The wood, when cut, is white; but after being wrought and exposed some time to the light, it assumes a roseate tint; its grain is fine and close, and when polished it presents a silky lustre. It is used in many of the states as a substitute for beech, birch, and elm; it is employed by wheelwrights for axletrees and spokes; it is made into Windsor chairs; it forms the keels and bottoms of many ships built in Maine; and it constitutes the framework of whole villages of timber-houses. The wood of the scarlet or swamp maple is largely used for the frame, nave, and spokes of spinning-wheels; for saddle-trees; for yokes, shovels, and wooden dishes; for bedsteads, nearly equal in richness and lustre to those of the finest mahogany; and especially for Windsor chairs, the manufacture of which is largely carried on at New York and Philadelphia, with maple wood brought down by canal and railway from the forests. The wood has a fine close grain, is easily wrought in the lathe, and acquires by polishing a glossy and silky lustre. Some of the old trees, in which the grain is undulated or curled, have so much strength and toughness added to the natural lightness and beauty, that the wood is eagerly purchased for making the stocks of rifles and fowling pieces. The wood of the white maple is whiter, softer, and lighter than that of the other species; it is used for making bowls, and in cabinet work, but not so largely as the two kinds just noticed. The wood of the sycamore maple is yellowish, compact, firm, finely-grained, sometimes veined, susceptible of a high polish, and easily worked at the bench or the lathe; it is very much employed in France and Germany by wheelwrights, cabinet-makers, turners, wood carvers, musical instrument makers, toy makers, gunstock makers, and the manufacturers of pestles, rollers, wooden spoons and platters, and numerous other articles: in England and Scotland it is used for many of the above-named purposes, and also for cider presses. Besides these various useful purposes, special examples of the maple are much prized for the beauty of their grain, rendering them well-fitted for surface-veneers for picture frames and cabinet-work. About one specimen in a hundred of the scarlet maple presents a wavy appearance, produced by a serpentine arrangement of the grain, rendering the wood difficult to split and work, but highly beautiful when smoothed and polished. Some specimens of the sugar maple present what is called a *bird's eye* arrangement of the grain; when smoothed and polished, the surface is diversified with roundish spots of peculiar character, reflecting flashes of light in a beautiful way. Mr. Holtzapffel, in an examination to discover the cause of this, found that the stem of the tree, when the bark is stripped off, presents little pits or hollows of irregular form—some as if made with a conical punch; others ill-defined and flattened like the impression from a nail-head. He found that these hollows are caused by internal spines or points in the bark. The layers of the wood being moulded as it were upon these spines, each fibre becomes abruptly curved at these points; insomuch that when cut through by the smoothing-plane, they give, in the tangential slice, the appearance of projections—just as in some rose-engine patterns and medallion-engravings, the closer approximation of the lines at their curvatures causes those parts to be more black or shaded, and produces upon the plain surface the appearances of waves or furrows and ridges.

There are many other economical uses to which the maple is applied. Charcoal made from the sugar-maple wood is much prized in countries where coal-fuel is scarce; while both the plain wood and the charcoal of the sycamore and white species have a high reputation for their heating qualities. The Kalmucks boil the maple-fruit in water, and eat it with milk and butter. The horses and cattle in Nova Scotia browse eagerly upon the leaves of the striped-bark maple. A coloured liquid, obtained by boiling the cellular matter of the inner bark, is used in America for black-dyeing. Potash is made extensively in the same region from the ashes of the burnt roots; and sugar is largely prepared from the sap, especially of the variety known as the sugar maple.

MARASMUS (emaciation) is a term often used by the older medical writers to designate those cases in which no particular cause for the atrophy of the body was discovered. It is now very rarely employed, since the condition which was thus named is known to be the result of various local diseases, by which the complete nutrition of the body is prevented, or by which a quantity of its material is constantly abstracted; as disease of the mesenteric glands, pulmonary consumption, diabetes, &c.

MARCH, the third month of the year according to modern computation, containing thirty-one days. The Roman year originally began with March, and was in fact so considered in England before the alteration of the style in 1752, the legal year commencing on the 25th of March. Our Anglo-Saxon ancestors called it most commonly *Hlyd monath*, loud or stormy month; and sometimes *Hraed* or *Rhæd monath*, which some interpret Rheda's, others *Rhede* or *Rethe*, the rugged or rough month. The name of the month is said to be derived from that of Mars, the god of war.

Before 1564 the computation of the French year began from Easter, so that occasionally the same year might comprehend two months of March, *Mars avant*, and *Mars après*. If Easter occurred in March itself, the month began in one year and ended in another. The change of computation from Easter to the first of January, in that country, was directed by an edict of Charles IX.

There is an old proverb, mentioned by various writers, which represents March as borrowing certain days from April. These are called, by the rustics in many parts both of England and Scotland, the *Borrowed Days*. They are particularly noticed in the poem called 'The Complaynt of Scotland:'

"March said to Aperill,
I see three hogs upon a hill;
But lend your three first days to me,
And I'll be bound to gar them die.
The first it shall be wind and weet,
The next it shall be snaw and sleet,
The third it shall be sic a freeze,
Sall gar the birds stick to the trees.
But when the borrowed days were gane,
The three silly hogs came hirplin hame."

Dr. Jamieson, in his 'Etymological Dictionary,' says, 'These days being generally stormy, our forefathers have endeavoured to account for this circumstance by pretending that March *borrowed* them from April, that he might extend his power so much longer. . . . . Those," he adds, "who are much addicted to superstition, will neither borrow nor lend on any of these days. If any one would propose to borrow of them, they would consider it as an evidence that the person wished to employ the article borrowed for the purposes of witchcraft against the lenders."

Ray, in his Collection, has a different proverb relating to this month, namely, that "A bushel of March dust is worth a king's ransom;" thereby expressing the importance of dry or dusty weather at this particular season of the year, in an agricultural point of view.

MARCH, in music, is, properly speaking, an air in duple time, played by martial instruments—that is, by inflatile and pulsatile instruments—to mark the steps of the infantry, as well as to amuse and cheer troops of all kinds. It however has long since gained admission wherever music is heard, and consequently is written for every kind of musical instrument. Hence some of the most striking compositions by the greatest masters; as, for instance, the marches in Handel's oratorios; the religious marches ('Marches religieuses') in Gluck's 'Alceste' and Mozart's 'Zauberflöte;' the two funeral marches ('Marcie funebri') of Beethoven; the 'Wedding March' of Mendelssohn, &c.

The true March is always written in common time, or in what is called a compound of that measure, and begins on a broken part of the bar, with an odd crotchet or a quaver. It is slow for grand or parade occasions, quick for ordinary marching. We are told by Rousseau, that Marshal Saxe used the march also for the purpose of accelerating or retarding the pace of his troops in battle. In his days there was more form, more ceremony used; something like etiquette was kept up in fighting: we doubt whether the movements of the battalions in the fields of Austerlitz and Waterloo were performed to musical movements, or even to the simple beat of drums.

MARCHES, THE. The *mark*, Anglo-Saxon meaꞃc, is a word common to almost all the languages of Teutonic origin. It was the first general division of landed property, and denoted in a specific and peculiar sense those important *marks* by which the boundaries of wide domains were indicated, within which individual or private possessions were contained, the mark being held in common, and in this sense it is found in Anglo-Saxon writings. Hence the word *the marches*, that is, the country lying near and about the *marks* which indicated the limits of two kingdoms, dukedoms, or other extensive jurisdictions.

In Germany, the *mark* gave one of the titles of honour, the *markgraf* (*margrave*), or lord of the marches. (Dönniges, 'Deutsches Staatsrecht.') Our own *marquess* is of the same origin, though it does not appear that the few persons who in early times (there was no English marquess before the reign of Richard II.) bore this title had any particular connection with the marches.

Great part of England being bounded by the sea, there could be but little march-land. But on the side toward Wales, and in the north where England abuts upon Scotland, there was march-land; and when we speak of the marches, the land near the borders of the two countries is what is meant.

Harold was lord of the marches against the Welsh, but after they were conquered by Edward I., we hear little in history of the marches of Wales. But the term continued in use long afterwards; and the family of Mortimer, whose chief residence was at Wigmore Castle in Herefordshire, had the chief management of the affairs of the Welsh marches, and bore the title of Earl of March. Edward IV., their lineal descendant and heir-general, was called Earl of March while his father was the Duke of York. The title is yet preserved in the family of the Duke of Richmond.

But Scotland remaining a distinct sovereignty for several centuries after the subjugation of Wales, the marches towards that country are frequently mentioned in history. The maintenance of authority in those regions was an object of great importance; and for this purpose the marches towards Scotland were divided into two portions, the western and the middle marches, each of which had courts peculiar to itself, and a kind of president or governor, who was called the warden.

MARCHESVAN, מַרְחֶשְׁוָן, commonly called Chesvan by the Jews, is the second month of the Jewish year, and it coincides with our October or November, according to the variations of length required to make each month commence with the appearance of the new moon. In the present year (1860) it begins on the 17th of October. The origin of the name uncertain; the Jews naturally look for it in the Hebrew root, רָחַשׁ, to "boil up," or pour forth." Benfey quotes Hyde, who proposes with more probability the Persian *khezán*, the autumn. We find the name *Markazana* on the monument of Darius at Behistun, but the season in which this month occurred is at present unknown. The word is not found in the Bible, but it was known to Josephus, who writes it Μαρσουὰν, or Μαρσουάνη, Antiq. l. i. c. 3, § 3. The Syrian months named Tisrin, which occupy the same period of the year, will account for the names of Θοριν and Θισιριν in the calendars of Heliopolis (Balbek). This month has either twenty-nine or thirty days, a variation which is applicable to the following month Chisleu also. In ordinary years Marchesvan has twenty-nine days and Chisleu thirty; when an additional day is required the two months have thirty days each; when it is necessary to have a short year both months have twenty-nine days. This variation is required for the purpose of applying a rule by which the month of Nisan could not begin on either Monday, Wednesday, or Friday; nor Tisri on Sunday, Wednesday, or Friday. No fasts or festivals of general observance occur in this month, though some mention is made of a fast on the 6th, in commemoration of the blinding of Zedekiah by order of Nebuchadnezzar (2 Kings, xxv. 7); and persons who have committed any excess on the Feast of Tabernacles in the preceding month may feel bound to a fast in Marchesvan.

MARCIONITES, a religious sect of the 2nd and 3rd centuries of our æra, so called from their teacher Marcion, a native of Sinope and a priest, who adopted the old Oriental belief, in which he had been preceded by Cerdo at Rome, of two independent, eternal, co-existing principles, one evil and the other good, introducing also a third intermediate being neither perfectly good nor perfectly evil, the creator of the inferior world and the legislator of the Jewish people. He endeavoured to apply this doctrine to Christianity, asserting that our souls are emanations of this third principle. The Jews were subject to this being, while all those nations who worshipped a variety of deities were subject to the evil principle. But the good principle, in order to dissipate these delusions, sent Jesus Christ, a pure emanation of itself, giving him a corporeal appearance and semblance of bodily form, in order to remind men of their intellectual nature, and that they cannot expect to find happiness until they are reunited to the principle of good from which they are derived. Marcion and his disciples condemned all pleasures which are not spiritual; they taught that it was necessary to combat every impulse that attaches us to the visible world; they condemned marriage, and some of them even regretted the necessity of eating of the fruits of the earth, which they believed to have been created by the evil principle. The Marcionites spread far in the East, and especially in Persia. The chief opponent of Marcion was Tertullianus, who wrote a book to refute his doctrines.

(Tertullianus, *Adversus Marcionem*; Mosheim's *Ecclesiastical History*, cent. ii., part ii.; Neander, *Church History*, vol. ii.; Beausobre, *Hist. de Manich.* l. iv., ch. 5, &c.)

MARGARAMIDE. When ammoniacal soap, prepared either from animal fat or olive oil, is treated with boiling water, the soap diffuses through it without being dissolved; on cooling the greater part solidifies on the surface, and this, if dissolved in boiling alcohol, deposits on cooling a substance which, when purified, has the following properties: it is white, crystalline, perfectly neutral, insoluble in water, very soluble in alcohol and ether, especially when hot. It melts at about 140° Fahr., and it burns with a sooty flame.

The solutions of potash and soda decompose it, when concentrated and boiling, ammonia being expelled and soap formed. Acids act upon it only when somewhat concentrated, and more readily when hot than cold. Its formula is $C_{34}H_{35}NO_2$. It is equivalent to margarate of ammonia less 1 equivalent of water; but as margaric acid is probably a mixture of palmitic and stearic acids, the existence of this body as an individual compound must be regarded as more than problematical. [MARGARIC ACID.]

MARGARATES. [MARGARIC ACID.]

MARGARIC ACID ($C_{34}H_{33}O_3$, HO), a fatty acid, so called by Chevreul, who discovered it, from "margarites" (*μαργαρίτης*), *a pearl*, on account of its peculiar lustre. It is prepared from soap made with olive-oil and potash; this is to be perfectly dried, and then macerated for twenty-four hours in twice its weight of cold alcohol. The *oleate of potash*, which the soap also contains, is dissolved by the alcohol, while the margarate of potash remains unacted upon; this is to be well washed with cold alcohol, and then dissolved in 200 parts of boiling alcohol: on cooling, the margarate of potash crystallises; and as it contains a little oleate, it is to be crystallised a second time: it is then to be decomposed, and the margaric acid precipitated by the addition of hydrochloric acid.

The properties of this acid are, that on cooling, after fusion, it crystallises in pearly needles; it is insoluble in water, and hence its precipitation from its compounds and solution by the stronger acids. It has an acid reaction; and its salts, except those of the alkalies, are very sparingly soluble in water. Its saline compounds are termed *margarates*.

The recent researches of Heintz seem to show that this acid is nothing more than a mixture of palmitic and stearic acids. [PALMITIC ACID; STEARIC ACID.]

MARGARIN ($C_{108}H_{104}O_{12}$), *Trimargarin, Margarate of Glycerin.* A peculiar fatty matter contained in vegetable oils, and also in animal fats, as mutton-suet, goose-grease, human-fat, and hog's-lard: when these have been treated with ether, for the purpose of obtaining stearin from them, the ethereal liquors, by spontaneous evaporation, deposit a portion of the solid matter which they contain, and this is to be collected on a linen cloth, strongly pressed, and then exposed for a long time to the heat of a salt-water bath. This substance is very soluble in cold ether, which distinguishes it from stearin. It consists of margaric acid united with glycerin.

MA'RGARON, a solid white fatty matter which crystallises in pearly scales, and is obtained by distilling margaric or stearic acid with excess of lime. It fuses at about 170° Fahr., is volatile, soluble in fifty times its weight of hot alcohol, and five times its weight of boiling ether. Exposed to the action of heat in close vessels it distils almost unchanged: it burns in the air with a brilliant flame. Nitric acid acts but slightly upon it; sulphuric acid chars it, and sulphurous acid is given out. The alkalies do not act upon margaron.

This substance is composed of—Hydrogen, 13·42; Carbon, 83·37; Oxygen, 3·21.

MARINE ACID. [CHLORINE; HYDROCHLORIC ACID.]

MARINE GLUE. [GELATINE.]

MARINE INSURANCE. [INSURANCE, MARINE.]

MARINER'S COMPASS. [COMPASS.]

MARINER'S CONTRACT. [SHIPS.]

MARINES, men embodied to serve as soldiers on board of ships of war in naval engagements; and on shore, in the event of a descent being made upon an enemy's coast. In the British service, they also assist occasionally in performing some of the operations connected with the working of the ship; they cannot however be sent aloft at the command of a naval officer.

Originally in this country, as well as in France, the national fleets were composed of merchants' ships, which were armed on occasion for war; and then there were no soldiers particularly destined for the naval service. The first troops of this kind in France were men skilled in the practice of the useful trades, who, when unemployed by the government, lived on shore on half-pay; receiving only the full pay when called upon to serve at sea. This regulation did not however long subsist; and, subsequently to the administration of Cardinal Richelieu, companies of marine soldiers have been constantly retained on full pay.

It is not precisely known at what period distinct corps were appointed in Britain to this branch of the public service. In 1684 mention is made of the duke of York's maritime regiment of foot; and in the reign of William III. several regiments were placed on the establishment of the navy, but these were subsequently disbanded. At that time the marine soldiers seem to have been retained as persons in training to become good seamen; and, in Burchet's 'Naval History,' quoted by Grose ('Mil. Antiq.,' vol. i.), it is said that they were discharged from the regiments and entered on the ship's books as foremast-men as soon as they became qualified to serve as such.

In the beginning of Queen Anne's reign (1702), six regiments of maritime soldiers were raised; and among the regulations concerning their service it is stated that they were to be quartered, when on shore, near the principal seaports. Whether at sea or on shore, they were to be paid at the same rate as the land forces, and the same deductions were to be made for clothing. At sea they were to be allowed provisions equal in every respect to the shares of the seamen, without suffering any diminution of pay on that account.

In 1749, the then existing regiments of marine soldiers, ten in number, were disbanded; and six years afterwards, on the recommendation of Lord Anson, there were raised 130 companies, consisting in all of above 5000 men, who were put under the immediate command of the lords of the admiralty, and whose head-quarters were appointed to be at Plymouth, Portsmouth, and Chatham. The corps of marines, as it was then called, has subsequently been considerably increased; in 1759 it numbered 18,000 men; and during the war at the beginning of this century, its strength amounted to about 20,000 men. An additional division was, by an order of council in 1805, established at Woolwich; and there were two companies of marine artillery, whose head-quarters were at Portsmouth. At present there are four divisions of royal marine light infantry, and one division of royal marine artillery, the head-quarters of the latter being at Portsmouth. The total strength is 17,459 non-commissioned officers and privates, 435 commissioned officers, and 106 staff officers.

The marines are now clothed and armed in the same manner as the infantry of the line, and, like all the other royal regiments, their scarlet uniform has blue facings. The marine artillery are dressed in blue with white facings. In an engagement at sea, they annoy the enemy by a fire of musketry from the tops and deck; and they repel with the bayonet any attempt to board the ship. The gallant *jollies*, as the marines are familiarly called, have often distinguished themselves when acting on shore; and their meritorious services at the taking of Belle-isle (1761), in the battle of Bunker's Hill (1775), in the defence of Acre (1799), and under Lord John Hay, on the coast of Spain, have earned for them a lasting reputation.

The corps is commanded by a deputy adjutant-general, who is assisted by an assistant adjutant-general, and is under the admiralty. There are also five colonels-commandant of divisions, besides five colonels second commandants. No commissions in the corps are obtained by purchase; and the officers of marines rise in it by seniority, as high only however as the rank of colonels-commandant.

MARIOTTE, LAW OF, also known as *Boyle's law*, refers to the law of elasticity in gases, and may be thus expressed: "The volume of an aëriform body is *inversely*, and its elasticity *directly*, as the pressure to which it is exposed." Hence, by doubling the pressure, we halve the volume; by trebling it, it becomes reduced to one-third; but by doubling the pressure we double the elasticity, by trebling the pressure we increase it three-fold, and so on. For those gases which have not been liquefied, or liquefied only under enormous pressures, the experimental results are nearly in strict accordance with the law, even under a pressure of several atmospheres. Such, however, is not the case for gases which readily liquefy. The nearer they approach the point of liquefaction the greater is the difference between the observed volume and the calculated result. The contraction is found to be more considerable than it should be if the law were strictly true. [AIR; ELASTICITY.]

MARITIME LAW. [ADMIRALTY COURTS; SHIPS.]

MARK, ST., THE GOSPEL OF. The genuineness and authenticity of this Gospel are attested by the unanimous voice of ecclesiastical writers. Michaelis has indeed objected to its canonical authority, in common with that of Luke, but on no good ground. According to Papias, Irenæus, and other early writers, Mark committed to writing the gospel which was preached by Peter; and Clement of Alexandria states that he did so at the request of Peter's hearers at Rome. Other early writers add that in this work Mark had the approbation and assistance of Peter; and many passages of the gospel have been thought to bear traces of being written under Peter's direction. From the tradition mentioned above, and from Latinisms and explanations of Jewish phrases and customs contained in Mark's gospel, it appears to have been written at Rome for the benefit of the Latin Christians.

The time when it was written is uncertain. Irenæus says that it was composed *μετὰ τὴν τούτων* (Peter and Paul) *ἔξοδον*; but whether he means *after the death* of Peter and Paul, or *after their departure* from Rome, is a question much disputed. Upon the whole, the most probable date appears to be about A.D. 64 or 66. There is little doubt that it was written after the Gospel of St. Matthew, and probably before the destruction of Jerusalem.

According to the unanimous testimony of the early ecclesiastical authors, the gospel of Mark was written in Greek. The Latin MS. at Venice, said to be part of St. Mark's *autograph*, has long since been proved to be nothing of the kind.

The opinion that Mark's gospel is an abridgment of Matthew's has been satisfactorily refuted by Michaelis; for notwithstanding the coincidences between these two gospels, we find, on comparing them, that there are in Mark omissions of and discrepancies with what is contained in Matthew, which it is difficult to account for on the supposition that he wrote with the gospel of Matthew before him. The true mode of explaining these coincidences and discrepancies belongs to the more general question respecting the origin of the first three gospels. Those who believe that each evangelist composed his narrative from independent sources of information have no difficulty in proving Mark's qualifications for the task; for besides the assistance which he probably received from Peter, what we know of his life proves that he must have had opportunities of constant intercourse with the apostles and first Christians.

(Lardner's *Credibility* and *Lives of the Apostles and Evangelists;* Cave's *Lives of the Apostles and Evangelists;* Kuinoel, *Comment. in Lib. Hist. N. T., Proleg. in Marc.;* Introduction to the Gospel according to St. Mark, in the *Pictorial Bible*, by Dr. Kitto, edit. 1849; and the *Introductions* of Michaelis, De Wette, Hug, and Horne.)

MARK. [MONEY.]

MARKET (*mercatum*), a public place and fixed time for the meeting of buyers and sellers. A legal market can exist only by virtue of a charter from the crown or by immemorial user, from which it will be presumed that a royal charter once existed, although it can be no longer produced. A market is usually granted to the owner of the soil in which it is appointed to be held, who, as such grantee, becomes the owner, or lord, of the market. In upland towns, that is, towns which, not being walled, had not attained the dignity of boroughs, markets were frequently granted to lords of manors; but in walled towns or boroughs, particularly in such as were incorporated, the ownership of the soil having usually, by grant from the crown, or other lords of whom the borough was originally holden, been vested in the incorporated burgesses, the course has commonly been to grant markets to the municipal body.

The prerogative of conferring a right to hold a market is however subject to this limitation, that the grant must not be prejudicial to others, more especially to the owners of existing markets. In order that the crown may not be surprised into the making of an improper grant, the first step is, to issue a writ ad quod damnum, under which the sheriff of the county is to summon a jury before him to inquire whether the proposed grant will be to the damage of the king or any of his subjects. This writ must be executed in a fair and open manner, and the sheriff is bound to receive evidence tendered against, as well as in favour of the grant. But as the writ does not purport to affect the interest of any person in particular, it is not necessary that notice should be given of the time or place at which it is meant to be executed. Notwithstanding a finding by the jury that the proposed market will not be injurious, any party who conceives that his interests are affected by the grant when made, whether he appeared upon the inquiry under the writ ad quod damnum or not, may traverse the finding, or sue out a writ of scire facias, which, after reciting the alleged injury, calls upon the grantee, in the name of the crown, to show cause why the grant should not be cancelled. If a new market be set up without any grant from the crown, the party is liable to be called upon by the crown to show by what warrant he exercises such a franchise [LIBERTY; QUO WARRANTO]; and he is also liable to an action on the case for damages, at the suit of any person to whose market, or to whose property, the market so set up by the defendant is a nuisance. A new market is presumed to be injurious to another held within the distance of twenty miles, even though it be on a different day, but this presumption may be rebutted.

Formerly markets were held chiefly on Sundays and holidays, for the convenience of dealers and customers, brought together for the purpose of hearing divine service. But in 1285, by 13 Edward I., c. 5, fairs and markets were forbidden to be held in churchyards; and in 1448, by 27 Henry VI., c. 5, all showing of goods and merchandise, except necessary victuals, in fairs and markets, was to cease on the great festivals of the church, and on all Sundays, except the four Sundays in harvest. The holding of fairs and markets for any purpose on any Sunday was prohibited in 1677, by 29 Charles II., c. 7.

The grantee of a market has a court of record called a court of pie-powder (pieds pouldreux, "dusty feet"), for the prompt decision of matters arising in the market. [PIE-POWDER COURT.] Such a court being considered necessary for the expedition of justice and for the support of the market, the power of holding it is incident to a grant of a market, even though the royal letters patent by which the grant is made be entirely silent on the subject.

Sales in markets may be of goods actually brought within the precincts of the market, or of goods not so brought. Goods not within the precincts of the market are sold sometimes by sample, sometimes without sample. Where goods are usually brought into the market for sale, it is incumbent on the lord of the market to take care that every thing be sold by correct and legal weights and measures.

For the security of dealings in markets, contracts were formerly required to be made in the presence of an officer appointed for that purpose by the lord of the market, for which service he received from the buyer a small remuneration called market-toll. [TOLL.]

It is a rule of the common law that every sale in market-overt (open market) transfers to the buyer a complete property in the thing sold; so that however defective the title of the vendor may be, yet that acquired by the vendee is perfect, even where the property belongs to a person who is under legal disability, as an infant, a married woman, an idiot, or a person in prison or beyond sea. In London every shop is market-overt for goods usually sold there.

This rule is subject to certain exceptions and restrictions. A sale in market-overt does not bind the rights of the crown; nor does it bind the rights of others, unless the sale be in an open place, as a shop, and not a warehouse or other private part of the house, so that those who go along cannot see what is doing, and not in a shop with the shop-door or windows shut, so that the goods cannot be seen. The articles bought must be such as the party usually deals in. The sale must be without fraud on the part of the buyer, and without any knowledge on his part of any want of title in the vendor. If the seller acquire the goods again, the effect of the sale in barring the true owner is defeated. There may be a sale and contract; and therefore the property is not altered in market-overt in goods given, or in goods pawned, or in goods sold to the real owner. The sale must be between sunrise and sunset; and must be commenced and completed in the market.

By 21 Henry VIII. c. 2, "If any felon rob or take away money, goods, or chattels, and be indicted and found guilty, or otherwise attainted upon evidence given by the owner or party robbed, or by any other by their procurement, the owner or party robbed shall be restored to his money, goods, or chattels." Since this statute, stolen goods, specified in the indictment, have, upon the conviction of the offender, been restored to the prosecutor, notwithstanding any sale in market-overt.

As stolen horses can be easily conveyed to distant markets, the legislature has frequently interposed to protect the owner against the consequences of a sale in market-overt. Thus, by 31 Elizabeth, c. 12, "No person shall in any fair or market sell, give, exchange, or put away any horse, mare, &c., unless the toll-taker, book-keeper, bailiff, or other chief officer will take upon him perfect knowledge of the person that shall so sell, give, or exchange any horse, &c., and of his true name, surname, and dwelling-place, and shall enter the same in a book there kept for sale of horses; or else that he so selling or offering to sell, &c., any horse, &c., shall bring unto the toll-taker or other officer aforesaid of the same fair or market, one sufficient and credible person, that can testify before such toll-taker, &c., that he knows the party that so sells, &c., such horse, &c., and his true name, surname, mistery, and dwelling-place, and there enter in the book of the toll-taker or officer, as well the true name, surname, mistery, and place of dwelling of him that so sells, &c., such horse, &c., as of him that so shall testify his knowledge of the same person, and shall also enter the true price that he shall have for the same horse, &c." And by sect. 4, "If any horse, &c., be stolen, and afterwards sold in open fair or market, and the sale shall be used in all points and circumstances as aforesaid, yet the sale of any such horse, &c., within six months after the felony, shall not take away the property of the owner, so as claim be made within six months, before the mayor or other head officer of the town or parish, if the horse, &c., happen to be found in any town corporate or market-town, or else before any justice of peace of the county near to the place where such horse, &c., shall be found, if it be out of a town corporate or market-town, and so as proof be made within forty days, by two sufficient witnesses, before such head officer or justice, that the property of the horse, &c., so claimed, was in the party by whom such claim is made, and was stolen within six months next before such claim, but that the party from whom the horse, &c., was stolen may at all times after, notwithstanding any sale in fair or market, have property and power to take again the said horse, &c., upon payment or offer to pay the party that shall have the possession and interest of the same horse, &c., if he will accept it, so much money as the party shall depose and swear before such head officer or justice of peace, that he paid for the same *bonâ fide* without fraud or collusion." This statute extends to a horse taken by wrong, though it be not stolen.

A market is generally appointed to be held once, twice, or three times in a week, for the current supply of commodities, mostly of provisions. A large market held once or twice a-year is called a fair; and, according to Lord Coke, a large fair held once a-year is a mart.

Fairs have all the legal incidents of markets, and are subjected to further regulations by 2 Edw. III. c. 15, one of which requires, that at the opening of the fair, proclamation be made of the time it is to continue.

MARKETS, AGRICULTURAL. The more numerous markets are in any well cultivated country, provided they are at a sufficient distance not to interfere with each other, and on different days of the week, the greater saving there is of time and labour of conveyance. Good roads or navigable rivers are of great importance to a market-town; and if there are mills in the neighbourhood, where corn can be ground, they will increase the advantage to the farmer by causing a regular demand above what the immediate consumption of the place may require.

The vicinity of a good market where every kind of agricultural produce will always find purchasers at a fair price, greatly adds to the value of a farm, especially if good roads lead to it; and the advantage is the greater if it be a populous town, which not only consumes much produce, but from which various kinds of manure may be brought by the teams which have carried the produce to market.

It is perhaps for the general advantage that the farmers should bring their corn in regularly, without speculating on a rise or fall of prices. Nevertheless they may be safely left to follow the dictates of their own judgment, influenced as that is by the rise and fall of prices, which are the only indications we have of the demand requiring supply. The farmer is tempted to withhold his corn when the price is low, in order to have a greater profit when it rises; and, to a certain degree, he is justified in doing so: but if he speculates on his own corn, when he can obtain a fair price for it, he becomes a merchant, as much as if he purchased to sell at a profit. When there is a good market at hand, the produce of the farm should be regularly sold, so as to give the farmer a constant supply of money for his operations, besides a portion set apart for the rent and other regular payments. In this way he will, at the end of the year, have had the average price, without risk and without speculation; and by a little caution he may obtain somewhat more than a mere average, provided he has always more money at hand than his immediate wants require, and is never forced to sell.

In order that the farmer may not be imposed upon, he must either make himself acquainted with the transactions in different neighbouring markets, or he must rely on the honesty and judgment of an agent, whose business it is to attend markets and buy and sell for others. These men are generally called salesmen or factors, and when their character for honesty is established, the small sum which is paid them on the sales will generally be found to be fully compensated by the advantage which their knowledge of the markets and of the quality of the articles gives them. This is particularly the case in the buying and selling of live-stock, which requires much more knowledge and experience than most other articles. The people whom the farmer has to deal with in fairs and markets have generally a thorough knowledge of the real value of the articles offered for sale, by constantly frequenting markets, and confining their attention to buying and selling only. The farmer is therefore seldom a match for the dealer, and will find it his interest to employ a person equally skilled in these matters. The farmer would lose too much valuable time, and be led to unnecessary expense, if he attempted to obtain the requisite knowledge by frequenting different and distant markets, as the dealers do.

Notwithstanding this, a certain knowledge of markets and prices is necessary to enable a farmer to detect imposition or ignorance in the person he employs, and the occasional attendance at fairs and markets is indispensable to obtain this knowledge.

When the whole bulk of the articles to be sold is brought into the market and exposed for sale, the market is called a *pitched* market; when only a small portion is brought, to show the quality of the whole, it is called a *sample* market. Each has its peculiar advantages and inconveniences. In a pitched market the buyer sees what he purchases, and can thoroughly examine it; he may therefore be induced to offer a more liberal price; but it often happens that he has to carry a load away by the same road by which it was brought; the sacks also have to be returned, which causes frequent mistakes and losses; and there is an evident waste of time and labour. When the article is sold by sample there is more reliance on the honesty of the seller, and the buyer naturally keeps on the safe side, by offering somewhat less, as a kind of insurance against slight deceptions. The buyer keeps half the sample and the seller the other, that they may be compared with the bulk in case of any dispute. The seller sends the article sold on a day agreed upon; and if it is corn, the sacks are brought back when the waggon or cart returns home. The price is usually paid on the next market-day. In very large dealings the selling by sample is generally adopted; small quantities are usually pitched.

Great inconvenience still arises from the various measures used in different markets; and dealers require tables to reduce them to one standard. The law which has established one uniform standard of weights and measures does not enforce its adoption, and a great variety of weights and measures still remains to perplex the dealer.

MARL, an earthy substance found at various depths under the soil, and extensively used for the improvement of land. It consists of calcareous and argillaceous earth, in various proportions, and as the former or the latter prevails, so it is beneficially employed on clays or sands. There are several distinct sorts of marl—clay marl, shell marl, slate marl, and stone marl. The clay marl has probably been formed by the slow deposition of clay suspended in water, and mixed with the particles of decomposed shells. When these shells have retained their form, or appear in fragments in the marl, it is called *shell marl*. A considerable compression and a complete decomposition of the shells form slate marl and stone marl. The effect of marl is the same as that of clay and chalk upon sandy soils; on heavy soils its effect is proportioned to the quantity of calcareous earth which it contains. The peculiar advantage of marl is its readily crumbling to powder by the effect of air and moisture. If it is too compact to dissolve under these influences, it can only be made useful by burning, and in this case it is only a substitute for lime, its value depending on the proportion of calcareous earth in the marl.

Marl is often found very near the surface, so as to mix with the soil in ploughing; but unless there be a sufficient depth of soil above, its presence does not indicate great fertility. It is generally best when found at a moderate depth, so as to be readily dug out and carted on the adjacent lands. In Norfolk, where a marl containing a large proportion of clay is found in many places under a light soil, it is frequently spread over the surface at the rate of two or three hundred cart-loads per acre. This dressing, joined to underdraining, makes a wonderful improvement on soils which before were scarcely worth cultivating, owing to their being loose and wet in winter. The clay marl makes them retain sufficient moisture, while the superfluous water is carried off by the drains.

Marl when put fresh upon the land requires some time in order to become effective. It should therefore be laid on the surface and spread before winter, leaving it there for a considerable time before it is ploughed in. It is most advantageous to put it on the land when it is in grass, and to roll and harrow it repeatedly, in order to expose it to the effect of the air and rains. Alternate frosts and thaws greatly assist its pulverisation.

An excellent use of marl is in forming composts with dung and peat earth. It is laid in layers with the dung and peat, and if the heap is well soaked with urine or the washings of stable-yards, it will in a short time become a most valuable manure for all kinds of soils. Many peat bogs are formed on a marly bottom; where this is the case, and it can be drained, or the water got rid of in any way, the marl, when laid on the surface, consolidates the peat by its pressure, and soon makes it capable of producing good herbage by converting it into a rich vegetable mould.

The expense of marling land can only be calculated when the distance of the marl and the depth from which it is raised are known; when it lies in a stratum under the land, it is generally the cheapest plan to open a pit in each field; for the carriage of the marl is the chief expense. Within a distance of two hundred yards from the pit, it is found by experience that the cheapest way of putting it on the land is by means of men wheeling it in barrows with the help of planks, as is done in digging canals and other similar public works.

It is in the compound character of certain limes that the subject of marling becomes connected with that of liming. As extraneous matters increase in quantity, and the lime diminishes, the effect of the application of course depends less and less on those considerations which explain the effect of liming, and the influence of the application of marl depends more and more upon the clay or sand, or it may be other things in smaller quantity which are thus conveyed to the land.

In a great many, perhaps the majority of instances, marl owes its fertilising influences to the lime which it contains, and then its effects are precisely those which lime would produce—sweetening herbage, increasing the quantity and improving the quality of crops. This it cannot do so energetically as is done by caustic lime, what lime it contains being in a state of carbonate: its dilution however, by other earthy matters gives it almost as great facility of mixture with the soil as is possessed by caustic lime on its reduction to powder by slaking.

In so far, however, as marling acts by its calcareous ingredient, its use has been supplanted by that of burnt limestone; and the marl pits of the country in Devonshire, Worcestershire, Staffordshire, Cheshire, Surrey, Sussex, Kent, and other counties, now have, many of them, large trees growing in them, proving how long a time has elapsed since they were used. Accordingly, where the use of marls still prevails, and it certainly does prevail to a very large extent in some districts in England, their effect is chiefly due to the other ingredients which they contain. We will specify a number of instances in which the fertilising effects of this application have been apparent. Holkham Park, in Norfolk, was let in 1776, to Mr. Brett, at 3*s*. per acre, and on the expiry of his lease, it was offered to him at an advance of 2*s*.; he refused to take it, and Mr. Coke, the landlord, took it into his own hands. The surface soil of the whole district is very light sand, but nearly throughout it there is a stratum of rich marl, at various depths underneath. Pits accordingly were opened, and the marl dug out and laid upon the surface. This not only increased its fertility, but gave to the soil the solidity which is essential to the growth of wheat. Here then the effect was due, not merely, nor perhaps chiefly, to the lime which this marl contained, but to its clayey part, which corrected the excessive looseness of the top soil. Take another instance of the effect of clays upon light sandy soil. In some of the lighter districts of Lincolnshire, it has been long a common practice to apply the white clay on the chalky soils in its neighbourhood, and the blue marl which lies in their valleys to alter and improve the nature of their red sandy soil. The white buttery marl used in these localities gives both strength and solidity to the lighter soil on the green-sand formation, and in a particular instance in our knowledge a farmer having applied it only to two lands in one of his fields, found that the yield of corn from those lands was fully 2 or 3 sacks per acre greater than from the remainder of the field. The marl is also found to prevent the clubbing of turnips, or the disease called fingers and toes, to which that land was subject. The blue marl is beneficial, but in a less degree. It is common to put on 40 loads per acre, and one dressing of the white clay is found to be amply sufficient for a great many years, it being questionable whether a second application on the red land is calculated to be useful.

In Suffolk the marl, which is clay containing small particles of chalk, is generally applied to the light soils, where it improves the mechanical texture of the soil, stiffens the straw of wheat, prevents the finger and toe in turnips, and seems to add the food which clover requires.

Take now the instance of marl applied upon peaty soils throughout the fens of Cambridgeshire and Lincolnshire. The best method is to dig trenches in the soil some two feet wide at intervals of 20 to 30 feet, taking one or two feet of clay out of them and spreading it over the surface; 100 cubic yards may thus be spread for 30*s*. to 35*s*. per acre. The light fen soil will after this grow first-rate crops of wheat, flax, and even beans. And even where the same crops are retained in cultivation, their greater produce amply repays the cost of the operation putting that at 50*s*. per acre or 6*d*. per cubic yard of the clay applied.

In illustration of the quantity of clayey marl which is put upon light and fen land in some districts of the country, we may name the case of Mr. Edward Witt, of Foreham, Suffolk, who has during six years applied on 183 acres of arable land nearly 52,000 loads, of 24 bushels each, at a cost of 463*l.* in manual labour; this is an average of 283 loads per acre of a cost of 50*s.* The West Suffolk Agricultural Society offers a prize of 4*l.* to the tenant who shall have carried and spread the greatest number of loads of clay during the previous twelve months, and a list for many years, given in the 8th vol. of the English Agricultural Society's Journal, shows the universality of the practice on light and fen land farm.

As a last illustration of the practice of marling we may refer to the use of chalk, which, though in some cases it must act chiefly by the lime which it contains, as when brought by railway out of Hampshire and applied at a cost of 4*s.* per ton, on the light lands of Surrey, is nevertheless used in large quantities where it can hardly be supposed that its usefulness depends upon its lime; as for instance on the chalk wolds of Lincolnshire, of Dorsetshire, and of Hampshire, where a dressing of 80 or of 100 cubic yards of chalk at a cost of less than 3*l.* per acre is spread upon the land: this with boning and feeding off with sheep being the means on which the farmer depends for fertility. The boning and sheep feeding are in constant operation; chalking is done at considerable intervals of time. One chalk is found to be much better than another for use in this way; differences which seem to indicate that their fertilising influence is not owing merely to their lime, but to some other ingredients—probably phosphate of lime, which is found in some chalk marls in considerable quantity. Thus, thanks to the researches of Messrs. Paine and Way into the chemical and agricultural character of the chalk formation, we have learned the existence of marl, containing very considerable proportions of phosphoric acid combined with lime, to which undoubtedly, and not to the carbonate of lime which it also contains, its fertilising influence is due. We may also mention as an illustration of the way in which the farmer may be misled by terms, that in this same district a bed of white earth is quarried and used upon the sandy lands of the locality with the best effect, which is called a marl, although hardly a trace of lime exists in it; the effect being no doubt due to the large proportion of the soluble silica which it is found to contain. It may be noticed that the shelly sand of the shore is largely used in Cornwall and on some parts of the Irish coast, and carried many miles inland, with the best effect on the fertility of the limeless soils to which it is applied.

MARMALADE, a sort of preserve, made with sugar and the Seville or bitter orange, a variety of the fruit of the *Citrus Bigaradia.* It is more wholesome when properly made—that is, when the rind is soft—than most other sweet preserves, as the bitter communicates tonic and stomachic properties to it.

The above is totally distinct from the material prepared from the Ægle Marmelos, a native fruit of India, which is there extensively used by the natives against diarrhœa and dysentery. It much resembles rhubarb in its properties, and, according to the dose, acts either as an astringent or mild laxative. It is now introduced into England, and used as a dietetic.

MARONITES, the name of a community of Christians belonging to the Western or Roman Church, and living on Mount Lebanon. They are neighbours of, and allied to, and in some places mixed with, the Druses, and, like them, independent in great measure of the Turkish power. The Maronites occupy the valleys and fastnesses of the principal ridge of Lebanon east of Beyroot and Tripoli, and they extend inland as far as the Bekaa, or plain between the Libanus and Anti-Libanus, where they are mixed with the Druses, though they do not intermarry with them. The tract of country in which the great bulk of the Maronites reside is called Kesrouan. It extends along the ridge of Libanus from the Nahr el Kelb, a stream which enters the sea 12 miles north of Beyroot, to the Nahr el Kebir, which enters the sea north of Tripoli, near the island of Ruad, the ancient Aradus, on which side the Maronites border on the Nosairis, or Ansarieh, who extend to the northwards towards Latakieh, and the Ismaelians, who live farther inland near the banks of the Orontes. To the eastward the Maronites have for neighbours the Metualis, a tribe of independent Moslems, of the sect of Ali, who live under their own emir, and occupy the belad or district of Baalbek and part of the Anti-Libanus; and on the south they border on the territory of the Druses, with whom they form one political body. [Druses.] In their internal concerns the Maronites are governed by their own sheiks, of whom there is one in every village, from whose decision there is an appeal to the bishops, who have great authority, and in some cases to the emir of the Druses, and his divan, or council. The clergy are very numerous; the secular parish clergy are married, as in the Greek Church; but the regular clergy, who are said to amount to 20,000, and are distributed among about 200 convents, follow the rules of St. Anthony, and are bound by vows of chastity and obedience. The Maronite monks are not idle; they cultivate the land belonging to their convents, and live by its produce. Every convent is a farm. The convents are under the jurisdiction of bishops, of whom there is one in every large village. The bishops are under the obligation of celibacy. The bishops collectively elect the patriarch, who is confirmed by the pope, and who resides at the convent of Kanobin, in a valley of the Libanus, south-east of Tripoli, where there is a printing-press, which furnishes the elementary books for the use of the Maronite schools. Not far from Kanobin is the large village of Eden, ten miles above which, and high up the Libanus, is the famed clump of old cedars, called the "cedars of Solomon," of large dimensions, but now reduced to seven in number (Lamartine, 'Voyage en Orient;' Richardson), not including the younger and smaller ones. Dr. Richardson measured the trunk of one of the old trees, and found it 32 feet in circumference. The whole clump of old and young trees may be walked round in about half an hour. Old cedars are not found in any other part of Libanus.

The Maronites derive their name from a monk of the name of Maro, who, in the 5th century collected a number of followers, and founded several convents in these mountains. When the Monothelite heresy prevailed in the East in the 7th century, and was favoured by the court of Constantinople, many Christians who did not embrace its tenets took refuge in the fastnesses of Libanus, around the convents, and thus the name of Maronites was assumed by the population of the mountains. This is the account of the Maronites themselves; others pretend that the Maronites were Monothelites, who took refuge in the Libanus after the Emperor Anastasius II. had condemned and proscribed their sect, in the beginning of the 8th century. [Eutychians.] Joseph Simonius Assemani, and his friend Ambarach, better known as Father Benedetti, have defended the Maronites from the charge of Monothelitism. Ambarach translated from the Arabic into Latin the work of Stephen, patriarch of Antioch, concerning the origin and the liturgy of the Maronites. In 1182 they were re-admitted to the communion of the Roman Church; and in 1736, at a great synod held at Marhanna, the Maronite Church formally acknowledged the canons of the council of Trent, but they retained the mass in the Syriac language and the marriage of priests. Before that time they received the sacrament under both forms, as in the Greek Church. At mass the priest turns towards the congregation and reads the gospel of the day in Arabic, which is the vulgar tongue.

The Maronite population is said to be above 200,000 individuals, and to contain between 30,000 and 40,000 men fit for military service. Every Maronite is armed, and they are all soldiers in case of need. Their language is Arabic, and by their appearance and habits they belong to the Arabian race. They are a fine-looking people, high-spirited, civil and hospitable, especially towards European travellers, and perfectly honest. Robbery and other acts of violence are hardly known among them. (Jowett, Light, Lamartine, and other travellers in Syria.) But Kinnear, who visited them in 1839, says, "happily for them, their religion exempts, or rather excludes, them from military service, and they escape the heaviest of all the evils under which their country has suffered—the conscription" ('Cairo, Petra, and Damascus, in 1839'), though he concurs in the favourable character given of the people. It would thus appear that a period of repose had relaxed their warlike qualities; and this is confirmed to some extent by the events of June, 1860. In that month, the Druses attacked the Maronites, who, though superior in number, made but a feeble resistance. Deis el Kama, their capital, was besieged, many villages destroyed and their inhabitants massacred, while the Turkish troops stood by and refused to interfere to repress the outrages.

There is at Rome, on the Quirinal Mount, a convent of Maronite monks, who perform the service of the mass in the Syriac language, according to the liturgy of their country. This church was founded by Pope Gregory XIII., and is dedicated to St. John. The monastery serves as a college for young Maronites who go to Rome to study and take orders, after which they return to their own country. It is one of those exotic colonies which give a peculiar interest to the city of Rome.

The ceremonies of these Maronites of Rome on great festivals, their chanting in Syriac, and their curious musical instruments, are described by the Abbé Richard, in his 'Voyage en Italie.'

MARQUE, LETTRES DE. [Privateering.]

MARQUESS, a title of honour used in England and on the Continent. Persons who have this title in England are the second in the five orders of English nobility. The dukes only are above them. In parliament all peers have the same privileges, by whatever title they are known. Marquesses in England have this privilege above earls, that their younger sons are addressed as "my lord," as Lord Clarence Paget, Lord Robert Cecil.

All titles of honour seem to have been originally the names of important offices, or to have denoted persons invested with a peculiar political character. Marquess is generally supposed, as we think justly, though other origins have been suggested, to have designated originally persons who had the care of the marches of a country. [Marches.] In Germany the corresponding term is *markgraf* (margrave), which seems to be "lord of the marches."

There were no English marquesses before the reign of Richard II. In the reign of Edward III. a foreign marquess, the Marquess of Juliers, was made an English peer with the title of Earl of Cambridge, and this circumstance probably suggested to King Richard the introduction of this new order of nobility. The person on whom it was conferred was his great favourite, Robert de Vere, Earl of Oxford, who was created Duke of Ireland and Marquess of Dublin in 1385. But the title had no long continuance in him, for three years after he was attainted and his honours forfeited.

In 1397 one of the illegitimate sons of John of Gaunt was created Marquess of Dorset; but he was soon deprived of the title, and his son had only the earldom of Somerset. The title of Marquess of Dorset was however revived in the same family in 1443, when, also, William de la Pole was made Marquess of Suffolk.

In 1470, John Nevil, Earl of Northumberland, brother to Richard Nevil, Earl of Warwick, the king-maker, was made Marquess Montacute; but he was soon after slain at the battle of Barnet, and the title became lost.

In 1475, Thomas Grey, Earl of Huntingdon, son to the queen of King Edward IV. by her former husband, was made Marquess of Dorset; and in 1489, Maurice Berkeley, Earl of Nottingham, was made Marquess of Berkeley. Henry VIII. made Henry Courtenay, Earl of Devonshire, Marquess of Exeter; and he made Anne Boleyn, a little before his marriage with her, Marchioness of Pembroke. William Parr, Earl of Essex, brother of Queen Catherine Parr, was created Marquess of Northampton by King Edward VI.; and William Powlett, Earl of Wiltshire, Marquess of Winchester.

All these titles had become extinct in 1571, except that of Marquess of Winchester. This title still continues in the male representative of the original grantee, though for a century or more it was little heard of, being lost in the superior title of Duke of Bolton.

Queen Elizabeth made no new marquess, nor did King James I. till the fifteenth year of his reign, when his great favourite George Villiers was created Marquess of Buckingham. Charles I. advanced the Earls of Hertford, Worcester, and Newcastle to be Marquesses of those places; and Henry Pierrepoint, Earl of Kingston, was made Marquess of Dorchester.

Charles II. advanced the Earl of Halifax to be Marquess of Halifax in 1682; and James II. made the Earl of Powis Marquess of Powis in 1687.

A new practice in relation to this title was introduced at the Revolution. This was the granting of the title of marquess as a second title when a dukedom was conferred. Thus, when Schomberg was made Duke of Schomberg he was made also Marquess of Harwich; when the Earl of Shrewsbury was made Duke of Shrewsbury he was also made Marquess of Alton; and when the Earl of Bedford was made Duke of Bedford he was also made Marquess of Tavistock. There were many other creations of this kind in the reign of William III., and several of marquesses only. It is not intended to name all the instances, either in this or the subsequent reigns. Of the existing dukes, eleven have marquessates in the second title, which is borne by the eldest son during the life of the father.

The only marquess who sits in the House of Peers as a marquess, and whose title dates before the reign of George III., is the Marquess of Winchester. The other marquesses, twenty-one in number, are all of recent creation, only seven dating from the last century, one of whom, Tweeddale, sits as a Scotch representative only, though most of them are old peers under inferior titles.

The title seems not to have been known in Scotland till 1599, when Marquesses of Huntley and Hamilton were created.

MARQUETRY and PARQUETRY, are two names for modes of grouping small pieces of wood into ornamental devices; the one for producing pictures and small decorative works, and the other for floors. During the middle ages, the specimens produced were generally alternations of black and white; but in the 15th century the Italians began to stain the pieces of wood in various colours, so as to afford facilities for much diversity of pattern. Afterwards, many of the beautiful woods of America were brought into use; and a method of representing shadows was devised, by scorching or singeing portions of the surface. In some examples the pieces of wood employed were so small, and the colours so selected, as to admit of the representation of landscapes and other pictorial subjects, in a certain rude way. Most marquetry work is a delicate kind of veneering. The ground-work is of well-dried oak or fir, secured from warping. The coloured woods are sawn into very thin plates and dyed or otherwise prepared. Supposing a flower in white wood on a black ground is to be produced by marquetry, there are three different modes adopted for cutting out the veneers to the proper shape. In the first method, a drawing or engraving of the device is cut into pieces; the pieces are pasted in proper position on two slabs of black and white veneer; and a very delicate saw, worked by a treadle, cuts the wood into the requisite shapes. In the second method the whole design is pasted on the black veneer; the leaves are cut out separately in white veneer, each white piece is pasted to the proper part of the paper, the black veneer is then cut through by a saw following the contour of the white pieces, the wood is separated from the paper, and lastly the white pieces are let into the holes cut in the black. In the third method a sheet of paper is pasted on the black veneer, upon this is placed a sheet of blackened or carbonised paper, and upon this again another sheet of white paper; the pieces of white veneer, properly cut, being pasted in proper position on the uppermost sheet of paper, a smart pressure or rolling will transfer a blackened device to the lowest sheet of paper sufficient to guide the sawing of the black veneer. The production of many-coloured marquetry will easily be understood from this description of the modes of cutting the veneers to produce black and white specimens. When the Italian and French marquetriers produce pictures instead of mere geometrical or fancy patterns, the work is frequently called *tarsia-work*. Numerous kinds of wood are employed, and much staining and scorching are resorted to. Holly is a favourite wood, because it is nearly white, and receives staining or dyeing very readily. M. Crémer, a French marquetrier, has in recent years produced many beautiful specimens, made of bits of veneer which had previously been dyed by Boucherie's process—that of causing the living tree to absorb saline and colour-producing solutions. At the Great Exhibition of 1851, many remarkable specimens of marquetry were shown—such as M. Bisso's table from Genoa, with a zodiac device on the top; M. Claudo's table from Nice, with four celebrated battles depicted in marquetry; an octagonal library table, made of 14,000 pieces of wood; and, most curious of all, the Spanish table made by M. Perez, of Barcelona, which was said to comprise no less than 3,000,000 minute pieces of wood.

Parquetry or *Parquetage* is a plainer kind of marquetry, little varied by colours, and applied as a flooring. The simpler varieties are said to have had their origin in a desire to avoid the warping of long narrow boards, by employing boards only three or four feet long by as many inches in width, and arranging them in various patterns. It rarely happens that there are more than two colours employed. Many old baronial halls exhibit flooring in which a smooth plain ground is adopted to show off a differently coloured wood cut into geometrical devices. Wood of one kind and colour is capable of yielding delicate patterns, something like that of a damask table-cloth, by placing the grain of the wood in different directions in different pieces. At Windsor Castle, the Royal Exchange, and other places, parquetry floors have been laid down in recent years. In some kinds the thin layers or veneers are fitted in stout oak frames formed into compartments comprising squares, diamonds, polygons, or any other desired shape; the oak frames are rather more than an inch in thickness, and the thick veneer is from a quarter to three-eighths of an inch thick. In other kinds no thin veneers are employed; the wood itself, not being costly, is used in pieces thick enough to be put together in a more expeditious and less costly way. There is a 'patent solid parquetry' now made in London for the flooring of mansions and public buildings, saleable at 1*s.* per square foot, for an inch in thickness.

The points of difference between small piece-meal productions in wood, metal, glass, enamel, and marble, will be understood by comparing the present article with INLAYING and MOSAIC.

MARQUOI'S RULERS. Among the methods which have been devised for facilitating the operation of drawing parallel lines, those which consist in making one ruler slide along the edge of another are in almost every case the most expeditious and accurate.

A triangular ruler, having two of its edges at right angles to one another, being made so to slide with one of its edges perpendicular to the length of a common rectangular ruler, constitutes, apparently, one of the first contrivances of this nature. It is said to have been originally employed in Germany, whence its use extended to other parts of Europe. A triangular ruler of the form just mentioned is called by the French artists an *équerre*.

The most approved construction and application of a triangular ruler are due to an artist named Marquoi, who resided in London, and by his name only the instrument is now known. Where many lines are to be drawn parallel and perpendicular to one another, as in making plans or elevations of buildings, or the horizontal projections of the ramparts of fortresses, such an instrument is particularly useful. The right-angled triangle, as well as the rectangular rulers which accompany it, is made of box-wood, ivory, or some metal; and on the surfaces of the latter rulers are certain scales with graduations in equal parts.

MARRIAGE is a contract by which a man and a woman enter into a mutual engagement, in the form prescribed by the laws of the country in which they reside, to live together as husband and wife during the remainder of their lives.

Marriage is treated as a civil contract even by those Christians who regard it as a sacrament, and as typical of the union between Christ and the church. The religious character of the transaction does not attach until there has been a complete civil contract, binding according to the laws of the country in which the marriage is contracted. The authority of the sovereign power in regulating and prohibiting marriages is therefore not affected by the super-induced religious character.

Among Protestants marriage has ceased to be regarded as a sacrament, yet in most Protestant countries the entrance into the marriage state has continued to be accompanied with religious observances. These are not however essential to the constitution of a valid marriage, any further than the sovereign power may have chosen to annex them to, and incorporate them with, the civil contract.

After the establishment of Christianity, in order to avoid the scandal of persons living together who were not known to be married, and also to secure and perpetuate the evidence of marriage, where really contracted, it became usual to make the marriage promise in the presence of the assembled people, and to obtain at the same time the blessing of the priest upon their union, except when one of the parties had been married before, in which case no nuptial benediction was anciently pronounced, the benediction once received by one party being considered sufficient to hallow the union as to both, unless by the distinction it was intended to intimate that second marriages, though tolerated, were not sanctioned by the church. So late however as the 12th century, in a decretal epistle of Alexander III. to the bishop of Norwich, the pope says, "We understand from your letter that a man and woman mutually accepted one another without the presence of any priest, and without the observance of those solemnities which the Anglican church is wont to observe, and that before consummation of this marriage he had contracted marriage with another woman, and consummated that marriage. We think right to answer, that if the man and the first woman accepted one another *de præsenti*, saying one to another, 'I accept thee as mine, and I accept thee as mine,' although the wonted solemnities were not observed, and although the first marriage was not consummated, yet the woman ought to be restored to her husband; since after such consent he neither should nor could marry another."

Private marriages, designated *clandestine* marriages by the clergy, continued to be valid till the Council of Trent, which, after anathematising those who should say that private marriages theretofore contracted by the sole consent of the parties were void, decreed, contrary to the opinion of 56 prelates, that thenceforward all marriages not contracted in the presence of a priest and two or three witnesses should be void. This decree, being considered as a usurpation upon the rights of the sovereign power, which alone can prescribe whether any and what formalities shall be required to be added to the consent of the parties in order to constitute a valid marriage, has never been received in France and some other Roman Catholic countries.

A marriage was clandestine if contracted otherwise than in public, that is, in *facie ecclesiæ*; and it was called an *irregular* marriage if it was clandestine, or if, though not clandestine, it was contracted without the benediction of a priest in the form prescribed by the rubric, the intervention of a priest having latterly been required in all cases, even though one of the parties were a widower or a widow. Clandestinity and irregularity subjected the parties to ecclesiastical censures, but did not affect the validity of the marriage.

The decrees of the Council of Trent had no force in England. A marriage by mere consent of parties, until the passing of the Marriage Act in 1753, constituted a binding engagement; though if application were made to the ecclesiastical courts for letters of administration, &c., under a title derived through such irregular marriage, those courts sometimes showed their resentment of the irregularity by refusing their assistance, more especially where the non-compliance with the usual formalities could be traced to disaffection to the Established Church. What the formalities required by the Church before the Marriage Acts were, it is now immaterial to consider. Such of them as are not incorporated into any of the Marriage Acts, are now of no force for any purpose.

To constitute a valid marriage, as well before as since the Marriage Acts, it is necessary, 1st, that there should be two persons capable of standing in the relation of husband and wife to each other; 2ndly, that they should be willing to stand in that relation; and 3rdly, that they should have contracted with one another to stand in that relation.

1. The capacity of standing in the relation of husband and wife implies that at the time of the contract there should be no natural or legal disability. Total and permanent disability on either side to consummate marriage will render the contract void. Temporary disability from disease does not affect the validity of a marriage. Temporary disability from defect of age does not invalidate the marriage, but it leaves the party or parties at liberty to avoid or to confirm such premature union on attaining the age of consent, which for males is 14, and for females 12. Before the abolition of feudal tenures, when the lords were entitled to sell the marriages of their male and female wards, infantine marriages were very common, fathers being anxious to prevent wives and husbands from being forced upon their children after their death, and lords being eager, either to secure the prize for their own family, or to realise the profit resulting from a sale. A person who is already married is under a legal disability to contract a second marriage whilst the first wife or husband is alive; and although there may have been the strongest grounds for believing that the first wife or husband was dead; the children of the second marriage would not in England derive any benefit from the absence of moral guilt in their parents, though in France and some other countries the issue of marriages so contracted, *bonâ fide*, are treated with greater indulgence.

Near consanguinity or relationship in blood is a legal impediment to marriage. The degree of nearness which shall disable parties from uniting in marriage varies in different countries, and has varied at different periods in our own.

This impediment is founded not only upon the moral but upon the physical constitution of man. The purity of domestic intercourse, the sanctity of affection with which the family circle is now united, would be at an end if matrimonial connections could be formed among its members; and even with the present restrictions intermarriages in families are frequently productive of the most injurious consequences in respect of mental and bodily health.

Affinity or relationship by marriage is an impediment arising out of moral considerations alone. The extent to which this impediment has been carried has also varied.

The impediment to marriage arising out of consanguinity applies in the same degree to illegitimate as to legitimate relations, and the impediment resulting from affinity is created by illicit connection as well as by marriage. The Council of Trent restricted the impediment of affinity arising out of illicit connection to the second degree.

2. Each party must have the will to contract marriage with the other. An idiot therefore, who cannot understand the nature of the conjugal relation, is incapable of contracting marriage. So is a lunatic, except during a lucid interval. But however absurd it may appear, children are presumed to have sufficient intelligence to understand the nature of the marriage engagement at seven; and though the contract is not absolutely binding upon them until they reach the age of consent, still the marriage of a child above the age of seven would prevent its forming a second marriage until the age of consent, as until that age it cannot dissent from the first marriage.

3. There must be an actual contract of marriage. This, at common law, might be by words of present contract, which would, without more, constitute a perfect marriage,—or by words of future contract, followed by cohabitation.

The unlimited freedom of marriage was first broken in upon in England by the Marriage Act of 1753 (26 Geo. II., c. 33), the principal provisions of which form the basis of the law as it now stands. Many of these provisions are taken from the canon law, an observance of which was, before this statute, necessary to constitute a *regular* marriage, though a marriage contracted without them was *valid*.

The restrictions upon the common-law freedom of marriage are now embodied in two statutes.

The 4 Geo. IV., c. 76, contains the following provisions: Banns of matrimony are to be published in the church, or a public chapel in which banns are allowed to be published, of the parish or chapelry wherein each of the parties dwells, immediately after the second lesson of morning service, or of evening service if there be no morning service, upon three Sundays preceding the solemnisation (s. 2). Notice of the names of the parties, their place of abode, and the time during which they have dwelt there, is to be delivered to the minister seven days before the first publication (s. 7). Banns are to be republished on three Sundays, if marriage do not take place within three months after publication completed (s. 9). No licence of marriage (that is, dispensation from the obligation to publish banns) is to be granted to solemnise marriage in any church or chapel not belonging to the parish or chapelry within which the usual place of abode of one of the parties has been for fifteen days immediately before the granting of the licence (s. 10). Extra-parochial places are to be taken to belong to the parish or chapelry next adjoining (s. 12). Upon obtaining a licence, one of the parties must swear that he or she believes that there is no impediment of kindred or alliance (consanguinity or affinity), or of any other lawful cause, nor any suit commenced in any ecclesiastical court, to hinder the marriage, and that one of the parties has, for fifteen days immediately preceding, had his or her usual place of abode within the parish or chapelry; and where either of the parties, not being a widower or widow, is under the age of twenty-one, that the consent of the person or persons whose consent is required by that act has been obtained, or that there is no person having authority to give such consent (s. 14). The father, if living, of any party under twenty-one, not being a widower or widow, or, if the father be dead, the guardian or guardians of the person of such party, or one of them, and in case there be no guardian, then the mother of such party if unmarried, and if there be no mother unmarried, then the guardian or one of the guardians of the person appointed by the Court of Chancery, has authority to give consent to the marriage of such party; and such consent is required, unless there be no person authorised to give it (s. 16). In case of the father, guardian, or mother being *non compos mentis*, or beyond sea, or unreasonably or from undue motives refusing or withholding consent, any person desirous of marrying may petition the lord-chancellor, master of the rolls, or vice-chancellor; and in case the marriage proposed shall, on examination, appear to be proper, the lord-chancellor, &c., may judicially declare the same to be so; and such declaration shall be equivalent to consent of the father, &c. (s. 17). If a marriage be not had within three months after licence, marriage cannot be solemnised without a new licence or banns (s. 19). The archbishop of Canterbury is authorised to grant special licences to marry at any convenient time or place (s. 20). If any persons, knowingly and wilfully, intermarry in any other place than a church or such public chapel, unless by special licence, or, knowingly and wilfully, intermarry without the publication of banns and licence, or, knowingly and wilfully, consent to the solemnisation of such marriage by a person not being in holy orders, the marriage is null and void (s. 22). (It has been held, that in order to invalidate a marriage under this section, both parties must know the irregularity of the proceeding.) When a marriage is solemnised between parties, both or one of them being under age, by false oath or fraud, the marriage is valid, but the guilty party is to forfeit all property accruing from the marriage (s. 23). After the solemnisation of any marriage by banns or licence, no proof can be required of actual dwelling or usual place of abode, nor can any evidence be received to prove the contrary (s. 26). Marriages are to be solemnised in the presence of two witnesses besides the minister, and registered.

The principal provisions of 6 & 7 Will. IV., c. 85, which was passed chiefly in ease of those who scrupled at joining in the services of the Established Church, are these:—Marriages may be solemnised on production of the registrar's certificate, under the provisions of that Act, in like manner as after publication of banns (s. 1). In every case of marriage intended to be solemnised according to the rites of the Church of England, unless by licence or special licence, or after publication of banns, and in every case of marriage intended to be solemnised according to the usages of the Quakers or Jews, or according to any form authorised by that Act, one of the parties is to give notice according to the form set out in the Act, to the superintendent registrar of the district or each of the districts within which the parties have dwelt for seven days then next preceding, stating the name and surname, and the profession or condition, and the dwelling-place of each, and the time (not less than seven days) during which each has dwelt therein, and the church or building in which the marriage is to be solemnised (s. 4).

After the expiration of seven days, if the marriage is to be solemnised by licence (that is, from the surrogate, or officer of the ecclesiastical court), or of twenty-one days, if without licence, the superintendent registrar, upon request, is to issue a certificate, provided no lawful impediment be shown, stating the particulars set forth in the notice, the day on which it was entered, that the full period of seven days or of twenty-one days has elapsed since the entry of such notice, and that the issue of such certificate has not been forbidden by any authorised person (s. 7). (This provision does not apply to marriages by licence celebrated according to the rites of the Church of England.) The like consent is required to a marriage solemnised by licence, as would have been required to marriages by licence before the passing of the Act (that is, by 4 Geo. IV., c. 76, ss. 16 & 17); and every person whose consent to a marriage by licence is required by law is authorised to forbid the issue of the superintendent registrar's certificate (s. 10). Every superintendent registrar may grant licences for marriage in any building registered within any district under his superintendence, or in his office (s. 11). Before any licence for marriage can be granted by a superintendent registrar, one of the parties must appear personally before him, and must, in case the notice of the intended marriage has not been given to the same superintendent registrar, deliver to him the certificate of the superintendent registrar or registrars to whom such notice has been given; and such parties must make oath, affirmation, or declaration, that he or she believes that there is not any impediment of kindred or alliance, or other lawful hindrance, to the marriage, and that one of the parties has for fifteen days immediately before the day of the grant of the licence (or rather the day of the making of the oath, &c.), had his or her usual place of abode within the district in which such marriage is to be solemnised; and where either party, not being a widower or widow, is under twenty-one, that the consent of the person or persons whose consent to such marriage is required by law has been obtained thereto, or that there is no person having authority to give such consent (s. 12). No marriage after notice, unless by virtue of a licence by the superintendent registrar, is to be solemnised or registered until after the expiration of twenty-one days after entry of notice, and no marriage is to be solemnised by the licence of any superintendent registrar, or registered, until after the expiration of seven days after the day of the entry of notice (s. 14). Whenever a marriage is not had within three calendar months after notice entered by the superintendent registrar, the notice and certificate, and any licence granted thereupon, and all other proceedings, become utterly void; and no person can proceed to solemnise the marriage, nor can any registrar register the same, until new notice, entry, and certificate (s. 15). The certificate of the superintendent (or superintendents) is to be delivered to the officiating minister, if the marriage is to be solemnised according to the rites of the Church of England; and such certificate or licence is to be delivered to the registering officer of Quakers for the place where the marriage is solemnized, if the same shall be solemnized according to their usages; or to the officer of a synagogue by whom the marriage is registered, if to be solemnised according to the usages of persons professing the Jewish religion; and in all other cases it is to be delivered to the registrar present at the marriage (s. 16).

Any proprietor, or trustee, of a separate building, certified, according to law, as a place of religious worship, may apply to the superintendent registrar, in order that such building may be registered for solemnising marriages therein; and in such cases he is to deliver to the superintendent registrar a certificate signed in duplicate by twenty householders, that such building has been used by them during one year as their usual place of public religious worship, and that they are desirous that the place shall be registered; each of which certificates is to be countersigned by the proprietor or trustee by whom the same is to be delivered, and the superintendent registrar is to send both certificates to the registrar-general, who is to register such building accordingly, and indorse on both certificates the date of the registry, and to keep one certificate with the other records of the general register office, and to return the other certificate to the superintendent registrar, who is to keep the same with the other records of his office; and the superintendent registrar is to enter the date of the registry of such building, and is to give a certificate of such registry under his hand, on parchment or vellum, to the proprietor or trustee by whom the certificates are countersigned, and is to give public notice of the registry thereof, by advertisement in some newspaper circulating within the county and in the 'London Gazette' (s. 18).

After the expiration of the twenty-one days, or of seven days, if the marriage is by licence (that is, from the surrogate), it may be solemnised in the registered building stated in the notice, between and by the parties described in the notice and certificate according to such form and ceremony as they may see fit to adopt, every such marriage to be solemnised with open doors between eight and twelve in the forenoon, in the presence of some registrar of the district in which the building is situate, and of two witnesses.

In some part of the ceremony, and in the presence of a registrar and witnesses, each of the parties is to declare—

> 'I do solemnly declare, that I know not of any lawful impediment why I, A. B., may not be joined in matrimony to C. D.'

And each of the parties is to say to the other—

> 'I call upon these persons here present, to witness that I, A. B., do take thee, C. D., to be my lawful wedded wife (or husband).'

Provided also, that there be no lawful impediment to the marriage of such parties (s. 20). Persons who object to marry in any such registered building may, after due notice and certificate issued, contract and solemnise marriage at the office of the superintendent registrar, and in his presence and in that of some registrar of the district, and of two witnesses, with open doors, and between the hours aforesaid, making the declaration and using the form of words as above (s. 21). After any marriage solemnised, it is not necessary, in support of such marriage, to give proof of the actual dwelling of either of the parties previous to the marriage within the district for the time required by the act, or of the consent of any person whose consent is required; nor is evidence admissible to prove the contrary in any suit touching the validity of such marriage (s. 25). The registrar before whom any marriage is solemnised according to the provisions of this act may ask of the parties to be married the several particulars required to be registered touching such marriage (s. 36). Every person knowingly and wilfully making any false declaration, or signing any false notice or certificate required by this Act, for the purpose of procuring any marriage, and every person forbidding the issue of any superintendent registrar's certificate by falsely representing himself or herself to be a person whose consent to such marriage is required by law, knowing such representation to be false, is to suffer the penalties of perjury (s. 38). If any person knowingly and wilfully intermarry under the provisions of this Act,—in any place other than the church, chapel, registered building, or office, or place specified in the notice and certificate,—or without due notice to the superintendent registrar,—or without certificate of notice duly issued,—or without licence, in case a licence is necessary,—or in the absence of a registrar, where the presence of a registrar or superintendent registrar is necessary, the marriage of such persons, except in certain excepted cases, is null and void (s. 42); as under 4 Geo. IV., c. 76, s. 22, a marriage would not be void unless *both* parties knowingly and wilfully concurred in marrying contrary to the provisions of the 42nd section. If any valid marriage be had under the provisions of this Act by means of any wilfully false notice, certificate, or declaration made by either party to such marriage, as to any matters to which a notice, certificate, or declaration is required, the attorney-general or solicitor-general may sue for a forfeiture of all estate and interest in any property accruing to the offending party by such marriage (s. 43). Consent to marriage may be withdrawn upon good reason; but it would rather appear that this cannot be done merely because the parent or guardian has changed his mind. The question of consent is not however of such vital importance as under the first Marriage Act (26 Geo. II., c. 33, s. 11), which made marriages without consent of parents, &c., absolutely void. Under 4 Geo. IV., c. 76, s. 23, and 6 & 7 Wm. IV., c. 85, s. 43, a false statement as to consent subjects the fraudulent party to the penalties of perjury, and to a forfeiture of all estate and interest in any properties accruing by the marriage, but leaves the marriage itself in full force.

The stat. 7 & 8 Vict., c. 86, provides for the licensing of district churches and chapels for the celebration of marriage. The stat. 19 & 20 Vict., c. 119, enables parties who have entered into the contract of marriage merely before the superintendent registrar to have the ceremonies of their church or persuasion added at any time afterwards. ('Black. Comm.,' Mr. Kerr's ed., vol. 1, p. 464.)

These statutes do not extend to marriages contracted out of England, or to marriages of the royal family, which are regulated by a particular statute, 12 George III., c. 11.

Before 1835, marriages within the prohibited degrees of consanguinity and affinity were valid until annulled by a declaratory sentence of the ecclesiastical court, after which they became void ab initio, and the issue of such marriages were, by such sentence, rendered illegitimate; and the law is still so with respect to personal incapacity existing at the time of the contract. But as the ecclesiastical court could, professedly, only proceed *pro salute animæ*, and its authority to annul an incestuous marriage was founded upon the duty of putting a stop to the incestuous intercourse, the power of annulling the marriage ceased upon the death of either of the parties. The validity of such marriage, and the legitimacy of the issue, depended therefore upon the contingency of a suit being instituted and a sentence pronounced, during the joint lives of the husband and wife. But now, by 5 & 6 Will. IV., c. 54, all marriages thereafter celebrated between persons within the prohibited degrees of consanguinity or affinity are absolutely void to all intents and purposes. And, even at common law, a marriage contracted while there is a former wife or husband alive is ipso facto void, without any declaratory sentence.

Generally speaking, a marriage, valid according to the law of the country in which it was contracted, is valid in every other country.

This rule is however subject to some exceptions, as where marriages, contracted according to the law of the country (*lex loci*), are considered, in the courts in which their validity happens to be contested as contracted in violation of some principle of natural religion or morality, or as where, in Persia or Turkey, a man marries a second wife in the lifetime of the first.

A constitution of the emperor Constantine, restored in 476 by the emperor Zeno (*Cod.*, lib. 5, tit. 27, l., 5), enabled the husband of a concubina who had children by her, without having had any child ex justis nuptiis, to raise the concubina to the dignity of justa uxor, and to confer on those children the privilege of children born ex justis nuptiis, though actually born ex concubinatu. This was carried still further when marriage was invested with a religious character. Its efficacy as a sacrament was regarded as so powerful, as to have a retrospective operation upon children born at the time when there was no semblance or intention of marriage of any kind, provided that at the time of the birth there existed no impediment to the marriage of the parents. Alexander III., who filled the papal chair from 1159 to 1181, pronounces that "Tanta est vis matrimonii, ut qui antea sunt geniti, post contractum matrimonium, legitimi habeantur." *Extravag.*, cap. 6, "Qui filii sunt legit." (Pothier, *Traité du Contrat de Mariage.*) This modification of the law of legitimacy, though frequently recommended by the clergy, was never adopted in England by the laity. It is however the law of Scotland as well as of France, and of most other Roman Catholic countries.

MARRIAGE, ROMAN. The right conception of the Roman institution of marriage and of its legal consequences is essential to enable us to approximate to a proper understanding of the old Roman polity.

Children were in the power of their father [EMANCIPATIO] only when they were the offspring of a legal marriage (justæ nuptiæ, or justum matrimonium). The cases of legitimation and adoption need not be considered here. To constitute such a legal marriage there must be between the parties *connubium*, the nature of which condition is best explained by an example:—Between a Roman citizen and the daughter of a Roman citizen there was *connubium*, and as a consequence the children of such marriage were Roman citizens, and in the power of their father. Between a Roman citizen and a female slave (ancilla) there was no *connubium*, and consequently the children which sprung from such a union were not Roman citizens. Whenever there was no *connubium*, the children followed the condition of the mother: when there was *connubium*, they followed the condition of the father. Various degrees of consanguinity, as the relation of parent and child, prevented *connubium* between parties in such a relation. After the Emperor Claudius had married Agrippina, his brother's daughter, such relationship was no longer an impediment to a legal marriage; but the license was carried no further than was warranted by the decree of the senate, and the marriage of an uncle with his sister's daughter remained, as before, an illegal union. (Tacit., 'Annal.,' xii. 7; Gaius, i. s. 62.) Further, to constitute a legal marriage, the two parties must be of sufficient bodily maturity; both parties also must consent, if they are capable of giving a legal consent (sui juris); or if not, their parents must consent.

The ceremonial parts of the marriage were of three kinds, by any one of which the wife was said to come into the hand of the husband (in manum), and to occupy the legal relation of a daughter. A woman who lived for one year with a man without interruption, became his wife by virtue of this cohabitation (usus). As in the case of all moveables, by the laws of the Twelve Tables, one year's enjoyment of a thing transferred the ownership of it, so by one year's uninterrupted cohabitation the husband acquired that interest in the wife which was the result of complete marriage. The Twelve Tables provided that if the wife wished to avoid the legal effect of this cohabitation, it was only necessary to absent herself from her husband for three nights during the year, which would be a sufficient legal interruption to the usus. In the time of Gaius, this part of the old law had been partly abolished by enactments, and had partly fallen into disuse.

The Confarreatio, so called from the use of a loaf of bread on the occasion, appears to have been of the nature of a religious ceremony, and it existed in the time of Gaius. It appears that certain offices, such as that of Flamen Dialis, could be held only by those who were born of parents who had been married by the ceremony of Confarreatio. (Gaius, i. 112; Tacit., 'Ann.,' iv., 16.)

The Coemptio was, in form, a sale (mancipatio) before five witnesses. [MANCIPIUM.] The Coemptio might be made either between a woman and her intended husband, in which case she became, in contemplation of law, his daughter, or between a woman and a stranger (fiduciæ causa), which was a necessary legal process in case a woman wished to change one guardian for another, or to acquire the privilege of making a will. For until the senatus consultum passed in the time of Hadrian no woman could make a testamentary disposition (with the exception of certain privileged persons), unless she had contracted the Coemptio, that is, had been sold, and then resold and manumitted. The Coemptio, being effected by mancipatio, worked a legal change of status ('Dig.,' 4. 5. 1), or *diminutio capitis*; and it was the least of the three kinds of *diminutio capitis*, or that by which a person underwent no change in his civil capacity, except the being transferred into another family. (Paulus, 'Dig.,' 4. 5. 11.) This explanation will render intelligible the passage of Cicero on the testamentary power of women ('Topic.,' 4), taken in connection with Gaius (i. § 115, &c.). The essays of Hoffmann and Savigny, in the 'Zeitschrift für Geschichtliche Rechtswissenschaft,' vol. iii., p. 309, &c., may also be read with advantage.

A gift from husband to wife, or from wife to husband, was void (with some few exceptions). The transaction was the same as if nothing had been done. The Donatio mortis causâ, or divortii causâ, in contemplation of death, or in consideration of divorce, was a valid gift.

There could be no *dos* (marriage portion), unless there was justum matrimonium. The term *dos* comprehended both what the wife brought to the husband on her own account, and what was given or contracted to be given by any other person, in consideration and for the purposes of the marriage. ('Dig.,' 23. 3. 76.) When the *dos* came from the wife's father, it was called *profecticia*, but when from any other person, *adventicia*. It was a general rule that the *dos adventicia* remained with the husband, unless there was some agreement to the contrary, in which case it was called *dos recepticia*. What came into the husband's possession, not as *dos*, was included in the term Parapherna (*παράφερνα*), or Paraphernalia, and did not become the property of the husband. All kinds of property could be the subject of *dos*. If they were things that could be estimated by number, weight, and measure (res fungibiles), the husband took them, subject to the liability in case of a dissolution of the marriage, of restoring things to the same number, weight, and measure. Things given as *dos* might be valued or not valued (æstimata and inæstimata); in case they were valued, the complete ownership of them passed to the husband, inasmuch as the valuation was in the nature of a sale, and the husband could dispose of the things as he pleased, subject only to the liability of restoring their value, in case of a dissolution of the marriage. If the things were not valued, and any loss ensued, without the fault or culpable neglect of the husband, the loss fell on the wife. In the case of things which were not fungibiles or not valued, the ownership during the marriage might be considered as in the husband, and as returning to the wife on the dissolution of the marriage. In such a case the husband could manage the wife's property as his own; he enjoyed the profits of it during the marriage, and could sell it. With some exceptions, however, he could not sell or dispose of the wife's immoveable property which was included in the *dos* (dotale praedium). (Gaius, ii. § 63; 'Instit.,' ii., tit. 8.) The portion became the husband's on the solemnisation of the marriage, and he had the profits of it during the marriage. In the case of divorce the portion, or a part of it, according to circumstances, was restored. In case the wife died during the subsistence of a marriage, part returned to her father, and part remained to the children of the marriage, if any; but it might, by the terms of the marriage contract, become the husband's, even if there were no children of the marriage. As to the portion of the wife, whatever might have been originally the rights of the husband over it by virtue of the marriage, it was in later times the subject of the express stipulations of the marriage settlement. The questions of law which arose on the subject of the *dos* were numerous and sometimes difficult.

In enumerating the modes by which a man may acquire property *per universitatem*, Gaius mentions marriage, by which a woman comes *in manum viri*, and he observes that all things pass to the husband. The meaning of this passage is perhaps not quite certain; but it is partly explained by what has been already said.

(*Dig.* 23, tit. 3, 'De Jure Dotium;' tit. 5, 'De Fundo dotali;' Ulpian, *Frag.*, vi., 'De Dotibus;' Thibaut, *System des Pandekten-Rechts.* See Lindley's translation.)

MARRUBIUM VULGA'RE (White Horehound), a biennial or perennial herbaceous plant, common by roadsides, the officinal part of which is the leaves; these are to be collected without the stalks. They are of a whitish-gray woolly appearance, possessed of a faint odour, which becomes less by drying, and a bitter sharp taste. Ten pounds of leaves yield four pounds of extract. Their chief constituents are a bitter extractive, with a volatile oil, and probably some astringent matter.

White horehound, when young, is apt to be confounded with many other labiate plants, particularly the *Ballota nigra*, or black horehound, which possesses a disagreeable odour. The medicinal properties of horehound are very insignificant, being demulcent, slightly tonic, and astringent. As a popular remedy, it enjoys great favour in many pulmonary complaints; but the preparations vended under the name of horehound often contain more efficient ingredients, to which they owe their success, especially opiates.

MARS, the planet which comes next to the earth in order of distance from the sun, is a brilliant star, of a slightly red tint. On examination in a telescope, this colour is found to belong to parts of the surface of the planet, which have been conjectured to be land; the rest, which appears somewhat green, being supposed to be sea. Certain white spots, which appear at each pole after the winter of its hemisphere, and disappear during its summer, have been conjectured to be snow. The apparent diameter of Mars varies from 3″·6 to 18″·28, being 6″·29 when the planet is at its mean distance from the earth. The real diameter is ·517 of that of the earth, or about 4100 miles.

Its bulk is ·1386 of that of the earth, and its mass is ·0000008927 of that of the sun, or about the 2546000th part.

The planet revolves on its axis in 24^{h} 39^{m} $21^{s}\cdot3$, and the axis is inclined to the ecliptic 30° 18′ 10″·8. Its light and heat are 43 per cent. of those of the earth.

Elements of the Orbit of Mars.

Epoch 1799, December 31, 12^{h} mean astronomical time at Seeberg.

Semiaxis major 1·5236923, that of the earth being assumed as the unit.

Excentricity ·0933070; its secular increase (or increase in 100 years) ·000090176.

Inclination of the orbit to the ecliptic 1° 51′ 6″·2; its secular alteration insensible.

Longitudes from the mean equinox of the epoch (1.) of the ascending node 47° 59′ 38″·4; its secular increase (combined with the precession) 2500″; (2.) of the perihelion 332° 22′ 51″; its secular increase (combined with the precession) 6582″; (3.) of the planet (mean) 232° 33′ 23″·2.

Mean sidereal motion in one mean solar day, 31′ 26″·655; in 365¼ days 689100″·739; sidereal revolution 686·9796458 mean solar days.

MARS, or MAVORS. [Ares.]

MARSH GAS. [Methyl, *Hydride of.*]

MARSH'S TEST FOR ARSENIC. [Arsenic, Detection of; *Marsh's Test.*]

MARSHAL, a term which in its origin meant simply a groom or manager of horses; but from the importance of such an employment in a rude warlike nation, the office of marshal became invested with great military authority, which, according to the usage of the times, drew to itself a considerable civil jurisdiction. One of the principal officers of state is the king's marshal, which office is now held hereditarily by the Duke of Norfolk, who is said to have the office of marshal of England, and also an honour in respect of which he is earl marshal. This office was executed in time of war in the king's host, or army; in time of peace, in the aula regis, or king's great court. Upon the division of the aula regis, the marshal appointed deputies in the new courts. In the King's Bench the marshal's deputy was called the marshal of the marshalsea of the king's court, or marshal of the King's Bench. In the Exchequer, the deputy was marshal of the Exchequer, or clerk of the marshalsea of the Exchequer. The duty of the acting marshal is regularly to attend the court, and to take into his custody all persons committed to his custody by the court.

The lord high constable, when there was one, and the earl marshal, were the judges before whom the court of chivalry or court martial was held. This court had cognisance of contracts touching deeds of arms and of war arising out of the realm, and of all appeals [Appeal] of offences committed out of the realm, and of matters within the realm relating to war, in cases which the courts of common law were incompetent to decide. Its proceedings were according to the course of the Roman or civil law. The earl marshal cannot hold this court alone, and there has been no hereditary or permanent high constable since the forfeiture of the Duke of Buckingham—"poor Edward Bohun"—in the time of Henry VIII. In the few cases in which the court of chivalry has been since held, a high constable has been appointed for the occasion. In the case of an appeal of death brought in 1583 against Sir Francis Drake by the heir of one Doughtie, whose head Drake had struck off in parts beyond sea, Queen Elizabeth refused to appoint a high constable; and thus, says Lord Coke, the appeal slept. The minor duties of the earl marshal are set out with great minuteness of details in a document preserved in Spelman's 'Glossary.'

MARSHALSEA. In the marshalsea of the king's household there were two courts of record. 1. The original court of the marshalsea was to hear and determine causes between the servants of the king's household and others within the verge; that is, within a circle of twelve miles round the king's palace. 2. The palace court was erected by Charles I., confirmed by Charles II., and had authority to try all personal actions between party and party, though neither of them were of the king's household, provided the cause of action arose within twelve miles round Whitehall.

The court of the marshalsea and the palace court were abolished by the statute 12 & 13 Vict. c. 101, as was also the old Marshalsea prison. (Blackstone's *Comm.*, vol. iii., R. M. Kerr's edit.)

MARSHES are those places of greater or less extent on the earth's surface, where the soil is almost constantly soaked with water. The swamp, the bog, the fen, and the morass, are so many different names for the same thing, or modifications which have not yet been defined. Whether marshes be considered with regard to their advantages or disadvantages, they are equally interesting, and are objects that call for the attention of individuals and sometimes of states. The advantages which they offer are of limited extent, and may be divided into spontaneous and artificial. The former consist in the natural productions which are furnished by some of them, of which peat is unquestionably the most important. (Ireland, Holland.) [Bog, in Nat. Hist. Div.] Some furnish iron-ore in considerable quantity—bog iron-ore—which is formed in them by the action of decomposing vegetable matter on water holding salts of iron in solution, arising from the decomposition of other iron ores; and, though generally of a bad kind, owing to the phosphorus it contains, it is sometimes very good, and worked with advantage (Siberia); others supply aquatic game in abundance, which is a great resource to the neighbouring inhabitants, either for consumption or as an article of commerce (the marshes of Tuscany); others again abound in eels and other fish; and some, as those of the Saône in France, and those of Poland, the Ukraine, and Bohemia, are valuable for the myriads of leeches which they furnish, and which are sent to distant parts. The soil itself, dug up from the marshes, which is called bog-earth, and the upper surface of the peat bogs, burnt or unburnt, are in many cases considered an excellent manure, and employed as such. (Poland, France.) The reeds, rushes, willows, &c., which grow so abundantly in certain marshy lands, are in many places objects of considerable importance. (Italy, Holland.) The artificial advantages to which marshes may be turned are confined chiefly to the cultivation of rice, where climate and other circumstances are favourable to the growth of this grain. (North America, Hungary.) The disadvantages of marshes are great: they are in general fatal to health, and agriculture suffers by the loss of all the marshy land. That health is materially injured by the pestilential air of marshes is evident from the fact that the ordinary mean length of life in their neighbourhood is very low. Cattle are also great sufferers from the influence of marshy grounds. The engineer Rauch says, "Marshes are the ulcers of the earth, which blur the fair face of nature, where all should be beauty; and from these infectious sores the languor of death extends far and wide over all that should live and flourish;" but the details of their baleful influence are nowhere more strikingly set forth than in the prize essay on this subject, by M. Ramel, of Paris.

A particular case, on a part of the Italian coast, derived however from another authority, will well illustrate this subject, so far as regards maritime marshes. Both ancient and modern authors have announced the fatal effects produced in the neighbourhood of marshes by the admixture of their waters with that of the sea, and a local belief of the same thing is very common and strong on the borders of the Mediterranean in Italy. On the south of the Ligurian Apennines is a marshy shore, bounded on the west for twelve miles by that sea, on the south by the river Serchio, and on the north by the Frigido, a torrent commencing at the foot of the mountains, in the state of Massa di Carrara, running three or four miles over the land, and then falling into the sea. The plain is from two to four miles wide, and is traversed by a few short streams, two of which divide it into three separate basins. The rain and spring waters which flow into these are slowly discharged into the sea by natural or artificial canals, penetrating the sand-banks on the sea-side. The level of these stagnant waters is between the levels of high and low tide in the sea, there being but little difference between these two points in this part of the Mediterranean. In this state of things, when the waters of the sea arose from any circumstance (unless the waters of the marshes were very high), they used to return up the ditches, fill the basins, and inundate the country to the foot of the mountains; and with a north-west wind, the waves used to penetrate with force to the interior. The mixture of fresh and salt-water thus formed, and which in summer was rarely changed, became corrupt, and spread infection of the most destructive kind over the neighbourhood. In this way the effects of the malaria were reproduced annually; the population, though small, presented feeble infants and diseased men, old age being unknown there. All attempts to avoid the scourge by living on the hills, or in the interior, and frequenting the plain only when the business of cultivation required, were vain; the inhabitants fell victims to the extensive influence, and much more rapidly did a stranger suffer from the deleterious atmosphere: a sojourn for one single night, in the months of August and September, causing inevitable death to the incautious traveller.

Such had been the state of things from time immemorial until 1740-1741, when, after the necessity of excluding the sea from these marshes had been insisted upon by many experienced persons, a sluice, with folding gates, competent to give emission to the waters of the marsh, but prevent the sea from entering, was constructed at the mouth of the Burlamacca. The most complete and unexpected success immediately followed upon and continued with this work. The year after its completion there were no appearances of the terrible maladies which previously appeared every year. The inhabitants soon recovered health, and the land being very fertile, the population rapidly increased. But the neighbouring parts were long left a prey to the destroying influence of the mixed marsh-waters. The 19th century had been some years entered upon before the inhabitants around other basins were considered; and it was not until so late a period as 1821, that the guarding with sluices of the remaining outlets from the marshes was complete. "Since that time," says Sig. G. Giorgini, whose account of these proceedings is here abridged, "the diseases of malaria have ceased so entirely at all points, that no other dangers are now incurred regarding the insalubrity of the atmosphere, than such as may arise from neglect of these sluices, which the inhabitants of the country should regard as their palladium." 'Ann. de Chim. et de Phys.,' 1825, vol. xxix., pp. 225–240.

The causes of the malarious condition of the atmosphere occasioned by the mingling of the marsh-waters with those of the sea, constitute too extensive a subject of investigation to be entered upon at any length in this place. It may be stated, however, that by the mutual re-action upon each other of the sulphates contained in the sea-water, and the vegetable matter partly suspended and partly dissolved in the water of the marshes, sulphuretted hydrogen gas is copiously evolved, which if not wholly identical with the deadly miasma, certainly forms a considerable and probably the most active part of it. Further information on this subject will be found in the article SEA, where its gaseous constituents and its particular nature on certain coasts are described.

Nevertheless all marshes are not equally prejudicial to health; but independent of their different degrees of insalubrity, they present other distinguishing features. The climate, the nature of the soil, and the vegetation, are all so many circumstances which vary the appearance and character of marshes. The quantity of water is also very different; in some cases it is hardly visible, while in others, at least in certain seasons, the marsh presents the aspect of a multitude of stagnant pools covered with aquatic birds. One of the five natural orders of birds, the Waders (*Grallæ* of Linnæus, *Grallatores* of Illiger and of Vigors) [BIRDS, in NAT. HIST. DIV.], are the characteristic feathered inhabitants of swamps and marshes; in addition to which their waters support their contingent of the order Swimming Birds, *Anseres* or *Natatores*, some of which are peculiar to them. This is the case with many of the Tuscan marshes, which are moreover remarkable for their floating islands, which sometimes unite and cover a large surface: these islands have little solidity, and, eventually sinking, become in time converted into peat, like those in the lakes of Cashmere; some of these marshes gain in extent, while the soil of others gradually rises, and the marsh disappears. Reeds are particularly abundant in the Tuscan marshes, and they are applied to a great number of useful purposes. The quality of the marsh-water also differs: thus, in some of the marshes of South Carolina, in the United States, it is salt, as likewise at Rochelle, Rochfort, &c., in France. In other places it is sulphurous, as is the case with the marshes of Mesopotamia; in many it is ferruginous, as in Siberia, where the marshes are strongly impregnated with sulphate of iron from the vitriolic springs which flow into them. The trees which are found imbedded in these marshes are so thoroughly impregnated with oxide of iron, that they supply an ore of excellent quality, furnishing a metal free from the defect of brittleness so common to the iron of most other bog-ores. In some cases the water of the marsh exhales an intolerable smell of sulphuretted hydrogen, arising from the decomposition of the sulphate of magnesia, or Epsom salts (which is continually forming on their banks), in conformity with phenomena already noticed. (Siberia, and the banks of the Euphrates.)

In cold countries marshes freeze, but seldom become dry; in warm countries, on the contrary, the marshes are often dry, and such can never form peat. As to the vegetation of marshes, it is either composed of reeds, rushes, algæ, gramineæ, or mosses, of which several species of *Sphagnum*, or bog-moss, are the most common in peat-bogs. Brushwood of various kinds, and willows and alders, are also common in marshy grounds.

Marshes are found in all kinds of situations, in continents and in islands (Iceland, Anau, &c.), on the margin of the sea, as well as in the interior of the land, on the slopes and even on the summits of mountains, as well as in the plains. Most countries have them in greater or less abundance, but it has been remarked that they are less common in Asia and in Africa (as far as the latter is known) than in Europe, and that they are more abundant in America than elsewhere. In this latter part of the world almost all the plains are wet and abound in marshes; they are exceedingly common in the northern countries of the globe, particularly in the flat parts bordering on the sea, where the land is low and the subsoil clay. Here the rain and snow-water accumulate, and remain for want of sufficient evaporation to carry them off.

It would be impossible to enumerate all the existing marshes: we may however observe that in Italy there are the Tuscan and the celebrated Pontine marshes, which are of great extent; in France there are about 1,500,000 arpens, or French acres, of marshes, some of great surface, as that of Montoire near the mouth of the Loire, which has been worked for its peat for upwards of five hundred years, and gives constant employment to 8000 persons. Ireland contains about 3,000,000 acres of marsh; the marsh or bog of Allen alone contains 300,000 acres, and there are others very extensive. England has had many marshes, particularly in Lincolnshire, Somersetshire, Kent, and Cambridgeshire; Chester, Huntingdonshire, Lancashire, and Stafford have also had extensive marshes, some of which contain embedded trees, but the improvements in drainage of modern times have rendered them insignificant, except in a few maritime localities. Scotland is much diversified with marshy ground, as in Peeblesshire, Ayrshire, Stirlingshire, Kinross, &c. As for Holland, the whole country is properly a drained marsh, and it still contains some extensive bogs which furnish peat. All the space along the coast from Holland to Denmark is little better than a succession of marsh and sand. Russia in Europe has marshes of vast extent, as those at the source of the Don, along the river Pripitz, and round the sea of Azoff, as also in Finland and the Baltic Provinces, in Lithuania and Poland. The eastern part of Prussia abounds in swamps. Norway and Sweden have some bogs, but little in proportion to their territory. In Bessarabia in Turkey, and all along the lower Danube, there are extensive marshes covered with reeds. In Hungary the marshes are estimated at 2,000,000 arpens. Switzerland has some considerable swampy patches, many of which are on the slopes of the mountains and in the higher valleys. In Spain and Portugal there are some extensive marshes; indeed they are more or less scattered all over Europe.

Asia has its marshes and swamps, but they are less common than in Europe, if we except the northern portion, where they are in great number and very extensive, as between the lower Ob and the Yeniseï, and between this last river and the Lena. There is between the little Tanguska and the Yeniseï the marsh called Lis, equal in extent to the great lake Ladoga, suspended as it were in the midst of rocky hills. The province of Okhotsk has many swampy forests. A large part of China is naturally swampy, but it is to a great extent drained by the numerous canals which intersect the country. Tonquin has many marshes, and the peninsula of Malacca contains many of great extent. In India, the province of Oude has some extensive marshes covered with reeds, the retreat of great herds of wild buffaloes. The mouths of the greater part of the rivers of India are marshy, and large swamps are sometimes found along their course, as is the case with the Padder. There is a vast marsh in the valley of Cashmere, between the city of that name and the Wulur lake, from which indeed it is only vaguely separated. In the northern provinces there are many savannahs, or wet meadows. There are swamps along the Euphrates; and those of Mesopotamia are bitter, sulphurous, and salt. In Persia the province of Ghilan, in other respects fertile and beautiful, is very unwholesome on account of its marshes and marshy forests. Mazenderan has also many swamps. The eastern side of the lake Aral is marshy. The steppes of the Kirghis abound in salt marshes and pools. The Asiatic islands, that is, all those that are of any extent, contain marshes: thus part of the coast of Sumatra is covered with extensive marshes, which have caused it to receive the name of "the pestiferous coast;" the reeds are gigantic bamboos, and a continual fog hangs over the aquatic soil. Batavia, Samarang, and other places in the island of Java are reputed to be so unwholesome, in consequence of the stagnant waters and pestilential marshes, that the island has been named the grave of Europeans. The Philippine Islands have a great many peat bogs. Australia has much marshy ground along the coast, and immense swamps have been seen inland.

As for Africa, its interior is too little known to enable us to speak with any certainty of its marshes; but the southern part, according to Barrow, has many and extensive swamps covered with reeds and saline plants. Some of the rivers on the east are marshy at their embouchures, which is also the case with the Quorra. Madagascar contains marshes, in which the singular Ravenala (*Urania speciosa*), a kind of palm, grows, remarkable for the size and disposition of its leaves, which are similar to those of the banana, and are employed by the natives as table-cloths, napkins, plates, dishes, and spoons.

America contains immense marshes. In the frigid zone of the New World, as far as known, fog-enveloped marshes have been found. To the westward, in Russian America, the land lying between the coast and the mountains is a slip of black swampy soil; some of the marshy grounds are on the slopes of the mountains and retain the water like a sponge; the verdure (being covered with moss of various kinds) gives them the appearance of firm land, but in endeavouring to pass them the traveller sinks up to the waist. On the opposite or east coast of America we find Newfoundland intersected by marshes and morasses. Lower Canada has neither marshes nor stagnant water. To the south of the great lakes of North America, and as far south as Mexico, the United States contain a great number of marshes, and some of them of great extent. The low lands of Mexico also contain many swamps. The former intendencia of Vera Cruz is principally occupied with marshes and sands. South America contains a great abundance of extensive marshes, as on the upper Apure, an affluent of the Orinoco; and the delta of the latter river is one vast swamp. The region which extends between the Andes and the Pacific has little marshy ground, if we except Chaco, where there are many swampy valleys; but on the other hand the immense plains which occupy the whole interior of the continent, from the mountains of Caracas on the north to the Straits of Magalhaens on the south, contain a great number of extensive marshes. All the immense basin of the Amazon is covered with swamps and wet land and marshy forests, many of which, however, at certain seasons, form the bed of the enlarged rivers. To the south of the Campos Parexis, the provinces of Moxos and Chiquitos contain extensive marshes; in the latter particularly there is the great lake or marsh of Xarayes. This marsh is temporary, however, being dry a great part of the year, and then covered with the corn-flag (*Gladiolus*) and other *Irideæ*. In the province of Cordova are the swamp of Los Porongos, the Mar-chiquito, &c. In La Plata there is the great marsh of Ybera, formed by the infiltrations of the Parana. At the north-west extremity of the Pampa of Buenos Ayres is the great reedy marsh called Los Canaverales, and along the whole course of the Rio Mendoza, and between that river and the foot of the Cordilleras, there are extensive marshes. They also exist on the upper part of Rio Negro. In short, we may say that all the immense region of the Pampas, or plains of South America, contains marshes. In ascending the coast we find the great island of Marajo at the embouchure of the Amazons, a considerable tract of which is a marsh, formed in part by the deposit from the water of the river, and in part by the sands of the sea. Farther north again the whole coast of French Guyana is a swamp.

This enumeration of the known marshes and swamps, though comprehensive, is however far from being complete. Very large portions of the earth's surface still remain unexplored. Nevertheless it is certain that the extent of marshy ground is very great; and probably it was formerly much greater, for a multitude of natural circumstances have greatly diminished marshes, and are still effacing them by degrees. On the other hand colonisation, and the consequent increase of population in the newly settled places, cause the clearing of forests and the draining of marshes to go on rapidly. There is no doubt that in proportion as the swamps are dried up the source of many diseases will be got rid of; but again, it may be doubtful whether the increased drought occasioned by so vast a reduction of evaporating surface may not engender other diseases equally fatal with those which now spring from the superabundance of swampy ground; and it is possible that even absolute sterility may result, in some cases, from imprudent drainage.

MARTELLO TOWER, a circular building of masonry, generally two stories high; the lower story is divided into chambers for the reception of stores, and the upper serves as a casemate for troops: the roofs are vaulted, and that of the upper story is shell-proof. The wall of the building terminates above in a parapet; and, on the terreplein of the roof are placed pieces of artillery, which rest on platforms of timber traversing on pivots, so that the guns are capable of being fired in any direction. The entrances are at a considerable height above the ground, and over these are machicolations. The whole work is generally surrounded by a ditch and glacis.

It is probable that the name of such works should be Mortella Towers, since it is supposed to have been derived from that of a fort in Mortella (Myrtle) Bay, Corsica, which after a gallant resistance was taken in 1794 by a British naval force. Many such towers were, during the late revolutionary war and since, built on the coasts of this country, in Ireland, in Jersey, and elsewhere. In England, after a period of disuse, many of these towers have recently been supplied with an improved armament.

MARTIAL ETHIOPS, the obsolete name for magnetic oxide of iron. [METALS: *Iron.*]

MARTIAL and MILITARY LAW do not mean the same thing; and though they are here joined for convenience, our observations shall be made upon each severally, without confounding it with the other.

Martial law, better known to some as drum-head law, is the arbitrary exercise of military power and authority for the purpose of enforcing complete submission, and is exerted, in the way of war, to whatever degree it be necessary, in quelling disturbance, dispersing mobs, repressing all signs of resistance, and punishing summarily on the spot any act of insubordination. It depends entirely on the will of the officer in chief command; who usually does, however, delegate this arbitrary power to a court-martial, composed of officers on the spot to judge of offences and to award punishment; and this is sometimes called a drum-head court-martial. It is this bitter kind of government, the most awful known in any state of civilised society, that the illustrious Duke of Wellington, upon an occasion still remembered in the House of Lords, when the present Earl Grey had made an inconsiderate appeal to the example of the distinguished soldier, deprecated being thought capable of ever applying to any civil community, except under modifications so extraordinary that one would scarcely have deemed the illustrious warrior's régime correctly entitled martial law. (Hans. Deb., 1 Apr. 1851.) By the Riot Act, the imperial parliament of this country has enabled the civil magistrate, when municipal authority is for the time set at defiance, and no longer avails to preserve the peace, to call out the military, and to give the commanding officer authority to disperse the people by force. The unfortunate condition of Ireland has frequently occasioned the express intervention of parliament to suppress insubordination by this kind of authority; and the lawless state of the people, evinced by agrarian outrages, and the perpetration and subsequent concealment of murder, under circumstances which demonstrated a cruel conspiracy of many and a general approval of the deed, has too often required the enforcement of a general Act, which enables the lord lieutenant to proclaim any district stained by such crimes and to place it under the surveillance of armed police, in greatly increased numbers, with greatly increased powers. These, however, are very modified instances of the application of martial law.

Military law, sometimes confounded with the other, is now in this country a well-known code of discipline applicable to her Majesty's land forces and marines, both in times of peace and war. It emanates necessarily from the authority of all laws in this country—the civil power. It is applicable only to the regular forces, unless by Act of Parliament the militia and volunteer forces, when enrolled, are placed under it. Civilians are amenable to the municipal law and no other, and any one who inflicts upon such a person in this country not *in statu pupillari* any punishment whatsoever except by authority of that law and the civil magistrate, is answerable for his conduct in a court of justice, civilly to the sufferer for the wrong done him, and criminally to the sovereign for the public offence.

This distinction between the two classes of persons with respect to military law is clearly expressed in the "Mutiny Act," as it is called, which was first passed in the reign of William III. After stating that the subjects of this realm cannot be punished in any other manner than conformably to the common laws of the country, an exception is immediately enacted in the case of military persons; and then follow several provisions for the purpose of bringing soldiers who shall mutiny, excite sedition, or desert from the service, to a more exemplary and speedy punishment than the usual forms of law will allow.

Immediately after the Norman conquest of this country the military law consisted in the obligation imposed on the vassals of the crown to follow the king to the field, under penalty of a pecuniary fine or the forfeiture of their land. But the first known record concerning the regulation of the army is believed to be that which was made in the reign of John; and this relates chiefly to the purchase of provisions at the sales held for supplying the army with necessaries. The ordinances of Richard II. and of Henry V., and the statutes of Henry VIII., contain many useful rules for the government and discipline of the army. They prescribe obedience to the king and the commanders; they award punishments for gaming, theft, and other crimes; for raising false alarms in the camp, and for the seizure of religious persons. They also contain regulations concerning the disposal of prisoners taken in battle, and concerning the stakes, fascines, ladders, and other materials for military operations, with which the soldiers were to provide themselves. (Grose, 'Mil. Ant.' vol. ii.)

The early kings of this country do not appear to have exercised, generally, a discretionary power over the army; for a statute of Edward I. states that the king had power to punish soldiers only according to the laws of the realm. The court of high constable and high marshal of England had for many years an exclusive jurisdiction in all military affairs, and this was sometimes extended over the civil courts. But the power of that court was restrained by a statute in the reign of Richard II. (1386); and the court itself, with the whole feudal system on which it was engrafted, gradually fell into disuse, and was displaced by an order of things with which it had little in common. No one however can point to the time that exactly divides the two eras. An interval occurred when it would have been difficult to say what was abiding. All was in a state of change: old things were passing away, and all things were becoming new. Charles I. was so unfortunate as not to discern the signs of the time. He placed himself in the breach, and hoped alone to stem the tide of progress; and there was a romantic chivalry in men's hearts which induced many to join him. They were borne down, and the genius of a great military system arose in Oliver Cromwell. The man himself was discipline; he made his soldiers, and they made him. The Stuarts returned with the Restoration. The army of 5000 men which Charles II., contrary to the constitution, maintained constantly in this country, became under his successor a body of 30,000 troops, arbitrarily levied, and therefore with difficulty retained to their standards on Hounslow Heath. Desertions became rife: pettier acts of insubordination were of course committed. The civil law knew no authority which could retain a man in the ranks against his will; and if he beat his officers, they might indict him for assault and battery, and the jury might refuse to convict. The celebrated Lord Holt, afterwards Chief Justice, was then Recorder of London. He maintained the law of England against the authority of James, who wished to enforce a discipline that rested entirely on his own sanction. Even Chief Justice Herbert found the demand of his sovereign too great for him, and he also maintained the civil law. Readier instruments were therefore found for the bench in London and at Westminster; arbitrary sentences followed; and death penalties and severe punishments astounded all the country, although applied to the army. The revolution at length succeeded this state of things, under the discernment of statesmen who knew the times were altered, and provided for them in accordance with the constitutional law of the country.

Prendergast, *Law of Officers of the Army;* Grose, *Military Antiquities;* Tytler's *Essay on Military Law*, by Charles James; Samuel, *Historical Account of the British Army;* Major Adye, *Treatise on Military Law;* Major-General C. J. Napier, *Remarks on Military Law.* See also COURTS-MARTIAL.)

MARTLET. [HERALDRY.]

MARTYRS, MARTYROLOGY, from the Greek *Martur* or *Martus* (*μάρτυρ* or *μάρτυς*), *a witness.*

By the term *martyr* we now generally understand a person who suffers death rather than renounce his religious opinions; and those who have made a profession of their faith and thereby endured sufferings short of death, are called *confessors.* These terms appear to have been used in the same sense by some of the early Christian writers; but others give the title of *martyr* to all who suffered tortures on account of their faith, and that of *confessor* to those who were only imprisoned for its avowal. Tertullian calls the latter "martyres designati," *martyrs elect.* The annals of the early Christian church contain the histories of many martyrs, whose astonishing fortitude under the most cruel tortures was doubtless one great cause of the rapid diffusion of Christianity. Among the earliest and most valuable documents relating to this subject are the letter of the church at Smyrna, giving an account of the martyrdom of Polycarp (A.D. 167), and that of the church at Lyon and Vienne, (A.D. 177), concerning the martyrs who suffered in the same reign, namely, that of Marcus

Aurelius Antoninus. (Eusebius, 'Ecc. Hist.,' iv. 5; v. i.; and Lardner's 'Works,' vol. vii., p. 150, edition of 1831.) The histories of these martyrs are called Martyrologies, of which the earliest is that of Clement I., bishop of Rome. Middleton has shown that many of the accounts in the early Martyrologies are fabulous. He mentions, in his 'Letter from Rome,' some curious instances in which persons who never existed, heathen deities with their names slightly or not at all changed, and even inanimate objects, have been canonised as saints and martyrs. As examples of this description of works we may mention the 'Martyrology' of Eusebius, which was translated into Latin by Jerome, and was celebrated in the early church, but is lost; that ascribed to the venerable Bede, but the genuineness of which is very doubtful; and the 'Acts and Monuments' of Fox, which is an elaborate and valuable record of the sufferings of the English reformers.

Much interesting information on this subject may be found in Ruinart's *Acta Martyrum;* Dodwell's *Dissertationes Cyprianicæ*, v., xi., xii., xiii., and Dr. Conyers Middleton's *Free Enquiry into the Miraculous Powers supposed to have subsisted in the Christian Church.*

MASCAGNIN ($NH_4O, SO_3 + 2\,aq.$), volcanic sulphate of ammonia, occurs stalactitic and pulverulent. Colour yellowish or grayish; taste acrid and bitter; translucent or opaque. Volatilised entirely at a high temperature. Occurs among the lavas of Etna and Vesuvius, &c.

MASCULINE and NEUTER. [GENDER.]

MASONRY (from the French word *maçonnerie*), signifies the application of stone to building purposes. It is a most important branch of the arts of construction; because much both of the beauty and durability of an edifice depends upon the excellence of the workmanship, and upon the colour and resistance of the stone. In situations where the geological character of the soil is clayey, or where stone is only to be obtained by means of a long and expensive land carriage, there is so important an economical advantage in the use of bricks, that stone is rarely resorted to, unless it be for the external decoration of important public buildings; and much of the style and taste of any particular locality may be attributed to the relative abundance of these materials, or rather, to the nature of the materials employed to produce the external effect of a building. Thus we find that in the greater part of England, and in Holland, where stone is only used exceptionally for elevations, and where brickwork is the normal mode of building, there is generally an absence of bold, and what may be called palatial, character in the prevalent style of architecture; whilst in Edinburgh, Paris, Genoa, Rome, Madrid, &c., the stone elevations of the houses and public buildings are marked by a breadth of handling our London architects rarely attain. Perhaps the great facilities for internal communication afforded by the railway system, may bring about a change in the style of construction adopted in London; but the facts of the co-relation between the habitual use of stone and the state of architectural taste, and of the influence which that material exercises on architecture, will remain the same.

Stone is used in walling, either in what is called rubble, or in ashlar masonry; or sometimes again in the style called brick and stone, or mixed masonry. Rubble masonry, in its turn, may be either random or dressed, according as the separate stones are dressed, or are left in the rough state in which they leave the quarry. Ashlar work is usually, but not necessarily, executed with large stones, which, under all conditions of size at least, are dressed to regular faces on the beds and joints; whilst the exposed faces may either be left rough, or they may be worked to a smooth surface. In mixed masonry the proportions of stone and brick vary greatly; for in some instances the use of stone is confined to the window-dressings, strings, cornices, &c., and in others it is further introduced in bonding courses, or alternate layers. Another technical subclassification of walling masonry is derived from the manner in which the faces of the stones are dressed; and according to the nature of the material: it is said, if granite be used, to be polished, fine gritted, fine axed, bolstered, or point dressed; if limestone be used, it is said to be rubbed, tooled, or hammer-dressed; and the same words apply to sand stones. In some styles of architecture an attempt is made to secure a certain amount of picturesque effect, by treating the surface of the stone in a bold, but affected, style of rough dressing, known amongst architects by the name of rustications, or of vermiculations. In these remarks upon the use of stone, attention has been only directed to walling purposes; because its application to window and door cills, to lintels, copings, staircases landings, paving, &c., is rendered so compulsory by the very nature of the requirements of the particular cases, that the discussion of the conditions of those branches of the mason's art must be left to the particular subjects themselves.

The qualities to be sought for in a building stone are durability, facility of working, capability of receiving a fine surface, and agreeable colour; but, as in all large towns, the state of the atmosphere is to a greater or less extent able rapidly to modify the original colour of the stone, the conditions of durability, and of the facility of working, in so far as the latter is likely to affect the cost of the work, are the most important. It would appear that there is some hitherto unexplained law affecting these questions, whereby the stone of any particular locality resists the atmospheric influences of that locality more successfully than it could do those of any other situation; but whatever may be the explanation of this phenomenon, it is certain that an atmosphere highly charged with carbonic, or with sulphuric, acid gases, is highly dangerous to the building stones usually employed. It is on this account that London and Manchester are so particularly unfavourable for masonry, and require such extraordinary care in the selection of the stones intended to be used in the elevations of public buildings in them, even without reference to the normal conditions of decay. As the atmosphere of every town has its own distinctive peculiarities, it may be as well to illustrate the above remarks by some incidental references to the action of the London atmosphere on the stones hitherto exposed to it; and to accompany them with some other incidental remarks on the accidental circumstances likely to modify the general laws thus arrived at. [ATMOSPHERIC INFLUENCE.]

The stone which hitherto has been proved to be the most adapted to resist the action of the London atmosphere is the Portland oolite: a fine-grained, sub-crystalline, carbonate of lime, of considerable hardness and density, and without any very distinct traces of bedding in the best varieties. The cost of the labour upon it, and the high price of the stone itself, on account of the limited source of supply, render the use of Portland stone less common than would be desirable, and have led to the introduction into the London stone market of cheaper and inferior materials. There are, however, some outlying patches of the Portland oolite which might be brought to London at the present day, such as the Tisbury, Upway, and Purbeck deposits; and it really seems that the fault of the high price of this variety of stone lies rather in the want of enterprise on the part of the merchants, than in any scarcity of the raw material. Portland stone, like all regularly stratified bodies, cleaves more easily in one direction than in others; but in the finer beds (that is to say, in the beds producing the finest stone) the character of the molecular structure becomes so homogeneous that the planes of stratification become imperceptible; and when this is the case there is less danger in using the stone, for ordinary purposes of masonry, in false bedding, than would be the case if the planes of separation of the beds were more distinctly marked. The best beds of the Portland stone are exposed to the inconveniences of flint nodules, and of vents, as the workmen call the cracks produced in the mass of the stone by the contractions which accompany its solidification. The upper beds, or the roach Portland, are shelly, more decidedly crystalline in the structure of the cementing material around the fossils, harder and more difficult to work, and totally unfit, on account of the numerous holes of the fossils, to be used in the masonry of ornamental structures; whilst, for hydraulic works, or other purposes requiring great strength and durability, the roach is of great value.

The member of the oolitic series which has supported the action of the London atmosphere the most successfully, after the Portland stone, is the material known as the Kelton stone, obtained from the midland counties; and, like the Painswick variety of the same formation which also stands tolerably well in London, it appears to owe this property to the more decided character of the crystallisation of the molecules of the cementing materials of the oolites. The Bath stone, when very carefully selected, and used with all necessary precautions as to bedding, and removal from excessive moisture, resists tolerably well; but the general character of the deposit is too irregular, and the habits of London masons are too careless in everything which regards the use of building stones, to allow either the Bath stone, or the analogous member of the great oolite obtained from Caen in Normandy, to be employed for external masonry in the metropolis. The Barnack stone, formerly used to a great extent in Lincolnshire, Cambridgeshire, and the Isle of Ely, has been exhausted, and its place is now locally supplied by the Casterton stone; these local varieties of the oolite are characterised by an abundance of minute fossils, corals, and foramenifera, and when well selected they seem to be tolerably durable. But it may be observed with respect to them, and to the Ancaster stone (a very beautiful looking material, said to be used successfully in the midland counties), that until they have been employed for a long time in the peculiar atmosphere of London, it would be dangerous to pass an opinion upon their merits.

There are several descriptions of sandstones used in London, and in various parts of England, for walling or external masonry, such as the Dundee and Arbroath stones, those from Cragleith, Darley Dale, Park Spring, and the neighbourhood of Leeds and Halifax; but neither on the score of their colour, or of their durability, can they be considered to be superior to the Portland stone. For some uses, as for steps, door cills, paving, hearths, &c., the Yorkshire and Arbroath stones present advantages on the score of their great strength, hardness, and ease of conversion in the direction of the bed, and also on account of their power of absorption of moisture, which renders their use desirable for all masonry works in the interior of dwelling houses. These sandstones when used in elevation are, however, exposed to decay "between wind and water," as the masons designate the zones of walls exposed to alternations of dryness or humidity. Unfortunately the magnesian limestones, lately introduced for the construction of the Houses of Parliament, have decayed in these positions even more rapidly than the worst sandstones formerly employed; and it is no exaggeration to say that the actual state of the masonry of that building has assumed the proportions of a national misfortune. The Kentish rag, so much used for the rubble filling between the dressed quoins of mediæval architecture, in the modern revival of that style, appears to resist the action of the atmosphere very well; but it is unfortunate that in these buildings the material used for the quoins is generally selected from the softest and most perishable stones. The conditions under which the siliceous conglomerates, such as the Bramley Fall, or the trap, basaltic, and granitic rocks decay, and which therefore must regulate their application for purposes of masonry, have already been discussed. [ATMOSPHERIC INFLUENCE.]

It follows from these observations upon the decay of stones that they require to be used with precaution, even when of good quality. Care should be taken to lay them in true bedding; the softer and more absorbent stones should not be used in the lower parts of a wall, or in situations where they would be likely to take up moisture from the ground, or from any projections of the ornamental masonry, by capillary action; and the use of limes, cements, or plasters, able to give rise to an efflorescence of the salts in the stones, must be avoided. There have lately been introduced some processes for the induration and preservation of building stones, the best of which seems at present to be Ransome's process, notwithstanding the adverse opinion of Faraday; but in fact every method for obviating the decay of a bad stone can be only a palliation, more or less perfect, for an original defect; and the common sense of this matter is to use originally a stone which should be able from its own constitution to resist the conditions to which it is likely to be exposed, rather than to attempt to remedy its defects. Highly ornamental masonry executed in soft stone may be, however, protected by the application of such processes as those above named; but they should only be regarded as hazardous and temporary methods of obviating present dangers, especially as their success must essentially depend on the care and skill with which they are applied.

In the execution of masonry, such as we generally see in the south of England, where the face is usually executed in ashlar of a less thickness than the wall, the ashlar is backed up with brickwork, which should be set in cement, in order to prevent any inconvenience from the unequal compression of the respective materials. Great care is also required in the execution of mixed masonry to obviate danger from the same cause; because the vertical chains of stone-work do not compress at the same rate as the filling-in brick-work, unless the latter be executed with a cementing material able to solidify in a very short space of time. The longitudinal courses of mixed masonry, as a general rule, run through the wall; or if this should not be the case the outer ranges of stones are connected with the mass of the work by means of bond stones, a system of construction equally applied to ashlar work backed up with brick. In other respects the rules for the execution of masonry are identical with those of brickwork; that is to say, the vertical joints in elevation should never be placed immediately over one another, nor should the facing work be distinct from the backing, in such manner at least as to allow any separation between the two.

Some mechanical distinctions between the various kinds of stones may here be alluded to, on account of their important influence upon the cost of masonry. Thus the granites, and the silicious conglomerates, are not susceptible of being sawn, but can only be detached in masses by means of wedges; the sandstones, and the harder oolites, can only be sawn by means of the framed, or plate saw, and sharp gravel and water; whilst such stones as the Bath, Caen, &c., are worked by the toothed saw. The first class above-described, or the stones unable to be sawn, are worked by means of points, or axes; and in remarkably fine works they are occasionally polished: the second class is worked by the hammer, the mallet point and chisel, and sometimes "rubbed fine:" the third class, or that of the soft oolites, is worked by axes or by tools slightly resembling those used by joiners, and the finished surface is, in England, obtained by the use of "the drag"—a tool very much like a short hand-saw. Rubble masonry is usually left rough from the tool, whilst Ashlar work, especially in the decorative parts of a building, such as strings, cornices, window and door dressings, &c., is either rubbed, or brought to a smooth face by the drag: in some cases however, as in what are called rusticated courses, the stones are occasionally worked with a straight chase round the joints leaving the remainder rough from the tool. [RUSTICS.]

The above remarks have been almost exclusively applied to the manner in which masonry is executed in London; but the leading principles they involve apply equally to that art in other countries; for the mode of bonding the material, the precautions to be observed in order to avoid unequal settlements when rubble and ashlar are combined, or when cementing materials of variable powers of expansion in setting are used, and the principles to be observed in selecting the stones and in placing them in a building, must be identical in every locality. It may be interesting, however, to the student of the arts of construction, to mention that the practice of the ancients in this particular branch has been elaborately described by Vitruvius; and that the practice of the moderns of recent times may be studied in detail in such works as Rondelet's 'Art de Batir;' or in Gwilt's 'Encyclopedia of Architecture.' Practically there is no difference between the styles of masonry adopted in former times and those now used, for the various systems of bonding used by the ancients, and described by Vitruvius under the names of the *opus insertum, reticulatum, imbricatum*, or *revinctum*, the *isodomum, pseudisodomum*, or the *emplecton*, are, in fact, only varieties of what would at present be described as coursed rubble, or small ashlar masonry. The Egyptians seem, however, to have attached great importance to the use of stones of large dimension, and even occasionally to have executed monolithic structures of considerable importance; and the taste for this peculiar element of sublimity of expression in buildings may also be said to have pervaded all the Eastern nations directly concerned in the early progress of civilisation, for it may be discovered in the monuments of Persia, Media, and in those of Tadmor and Palmyra. The character of the materials used by the Greeks (that is to say, the large straight block), which they obtained with facility from their marble rocks, had a marked influence also on the expression of their architecture, insomuch as their masons were able to span large openings by straight beams or lintels; whereas the Romans, and, generally speaking, the inhabitants of the West of Europe, have been driven, by their lack of materials for the execution of such trabeated masonry, to resort to the use of bricks, or of small stones, used as arches for the purpose of spanning the openings so much more easily dealt with when long lintels could be obtained. The Cyclopean masonry, as the irregular rubble work executed with stones of enormous dimensions, is called, and of which antique specimens are to be seen in the countries formerly inhabited by the Pelasgic tribes, or in the modern structures of parts of Germany and of Spain, is again little else than a modification of the styles of masonry already described.

In some cases, where coloured marbles are obtained at small expense, they are applied as ornamental decorations by being let into panels in the external walls, or even in some instances they are exclusively used for the face work. Nearly all marbles are pure carbonates of lime of a highly crystalline character, and they are therefore exposed to the destructive actions before alluded to as being likely to affect the more earthy carbonates, although in an inferior degree. For internal masonry, however, marble may be used without hesitation in situations at least where the following objections would not apply; that is to say, that when used for chimney-pieces marble is exposed to a slow calcination if placed too near the fire-place, and it loses its crystalline to assume a saccharoid texture in proportion as the carbonic acid gas is driven off by the heat. The marbles, again, which contain veins of a different nature to the mass of the material, are exposed to unequal contractions, and the Italian black and gold, for instance, or the serpentines (though strictly speaking the latter can hardly be called marbles), frequently crack upon the lines of the veins. Marble is in some countries, as in Holland, much used for lining the walls, and paving entrance halls; but unless great care is taken to maintain an equable temperature, and a great degree of dryness in the atmosphere, a very unpleasant condensation of vapour takes place upon the face of the marble, in consequence of its powers of rapid conduction, and of its non-absorption. At the present day the fashion is to use foreign marbles for ornamental masonry, and the English market is supplied from Belgium and Italy; but there are some singularly beautiful materials of this description to be obtained from our own country, and their neglect must be a cause for regret to artists and to economists. Marbles are worked by the mallet and chisel, and sawn by the plate-saw; indeed, on account of their uniform character, they are susceptible of being worked by steam machinery.

MASONS, FREE. According to the extravagant and whimsical hypotheses entertained by some of those who have written upon the subject of freemasonry, it is an institution of almost incredible antiquity. We are told by some that it originated with the builders of the tower of Babel, though others are content with tracing it no farther back than the temple of Solomon. If we are to believe them, the institution has been continued down in uninterrupted succession from that very remote time to the present day, through all the changes of governments, religion, civilisation, and knowledge. Against this there exists one very simple, yet fatal, argument, namely, that were this really the case, such an uninterrupted series of tradition must have kept alive and handed down to us much information that has, on the contrary, been utterly lost. Instead of accumulated knowledge, we find that even a technical knowledge of architecture itself has not been so preserved; else how are we to account for the ignorance which everywhere prevailed with respect to Gothic architecture and its principles almost as soon as the style itself fell into disuse? That there may have been many points of resemblance between the fraternities of masons in the middle ages, and such institutions as those of the Eleusinian mysteries, and the corporation of Ionian architects, is not only possible, but highly probable, because similarity of circumstances would almost necessarily lead to it. Before the invention of printing, when the means of communicating knowledge were few and imperfect, no readier mode presented itself of extending and keeping up the speculative and practical information spread among any profession, than by establishing the profession itself into a community or order, all the members of which would have one object and one interest in common. This would be more particularly the case with regard to architecture, which calls for the co-operation of various branches of science and the mechanical arts, and was moreover for several ages the paramount art, all the other arts of decoration being, as far as they then existed, subservient to it.

The importance of architecture to the church, on account of the impressive dignity it conferred upon religious rites and the ministers of religion, naturally induced the clergy to take it under their especial protection. For a long time not only were ecclesiastics the chief patrons but almost the chief professors of the art; yet as they had occasion for the assistance of practical artificers in various branches, they admitted them into fellowship with themselves, establishing a kind of order of a mixed character, just as the orders of chivalry combined at their origin the principles of military and religious discipline. Hence some have supposed freemasonry to have been a branch of chivalry, and to have been established at the time of the Crusades. The more probable hypothesis perhaps is that they were related to each other only in emanating from the same source—from the influence of ecclesiastical power; and their being so derived would alone account for the mystery and secrecy which the guilds of masons affected; and, together with their zeal in accumulating knowledge for themselves, their desire to confine it to their own body.

By means of these associations the inventions and improvements made in architecture were communicated from one country to another, a circumstance which at once accounts for the sudden spread of pointed or Gothic architecture throughout the whole of the west of Europe; and at the same time renders it so exceedingly difficult to determine at all satisfactorily where that style actually originated, or what nation contributed most towards its advancement. Owing also to the jealousy with which the masons kept their knowledge to themselves, it is not at all surprising that the history of the art during the middle ages should be involved in so much obscurity that it can now be traced only by its monuments, all documents relative to the study of it having been concealed as much as possible, even when something of the kind must have been in existence. Among the causes which led afterwards to the decline of these institutions was, on the one hand, the suspicion with which the church itself began to regard them as societies that might in time acquire an influence not easily watched, and which might be turned against itself; and on the other, the spread of information, together with the revival of the arts, which deprived such bodies of their utility and importance, and rendered it impossible for them to confine their knowledge exclusively within their own pale.

In this country an act was passed against Masonry in the third year of Henry VI., at the instigation of the Bishop of Winchester. It was however never enforced, and Henry himself afterwards countenanced the brethren by his presence at lodges of masons. It was also patronised by James I. of Scotland: but it was no longer indispensable to the church, which accordingly withdrew its protection—an event that would otherwise have been occasioned by the Reformation.

Freemasonry revived again in this country about the time of the civil war, yet merely in semblance, being altogether different in object and character from what it had been, and becoming merely "speculative" or modern Masonry, an institution in nowise connected with architectural practice. From this country it was first introduced into France about the year 1725; into Spain in 1728, and into Italy in 1733, when the first masonic lodge was established at Florence. It was afterwards however the object of persecution not only in France and Italy, but also in Holland and Germany. Some writers, more especially Abbé Baruel and Professor Robison, have made it a charge against freemasonry that it has been converted into an organised secret conspiracy against religion and existing governments. If the charge has been unjustly made, it must be owned that the profound mystery in which it has cloaked itself gave some colouring to such charges, it being but natural to infer that if there was anything to call for such extraordinary degree of secrecy, it could hardly be aught for good, or in accordance with the interests of society at large. The greater probability is, that there is nothing either good or bad to conceal; that the mystery of freemasonry is nothing more than an innocent mystification; and that its symbols and instructions, whatever meaning or purpose they may originally have had, are now become mere forms and signs retained by the brethren, or "free and accepted masons," as they style themselves, for the purpose of conferring peculiar importance on their harmless social meetings.

MASQUERADE from the Spanish *mascara*, (which is from the Arabic *mas-chara*, a mimic or sport-maker, Italian *mascherata*, and French *mascarade*), an amusement introduced into England in the 16th century from Italy, though the use of masks for purposes of satire is of great antiquity, and was practised by the Greeks and Romans. Hall in his 'Chronicle,' says, "On the daie of the epiphaine, at night (A.D. 1512-13), the king (Henry VIII.) with eleven others were disguised after the manner of Italie, called a maske, a thing *not seen afore in England*: thei were appareled in garmentes long and brode, wrought all with golde, with visers and cappes of golde; and after the banket doen, these maskers came in with the six gentlemen disguised in silke, beryng staffe torches, and desired the ladies to daunce: some were content; and some that knew the fashion of it refused, because it was not a thing commonly seen: and after thei daunced and commoned together, as the fashion of the maskes is, thei toke their leave and departed, and so did the quene and all the ladies."

The distinction between this species of amusement and the disguisings and mummings of the middle ages appears to have been the general mingling of the company in dance and conversation, in lieu of the execution of a particular dance or preconcerted action by certain individuals for the entertainment of the guests, the latter being as old at least as the time of Edward III. in England, and the precursors of the dramatic masque of the 16th century. In "the garmentes long and brode," and "disguisings of silke," we may perceive the present *domino*, so called, according to some authorities, from an ecclesiastical vestment (a black hood worn by canons of cathedrals), *dominus* being a title applied to dignified clergymen in the middle ages. Others derive it from the ordinary robe or gown worn by Venetian noblemen at that period. Granacci, who died in 1543, is said to have been the inventor of masquerades: at what particular date does not appear; but from the above evidence of Hall, they had become fashionable in Italy as early as 1512. In England the disguisings are of the most fantastic variety, but the characters assumed as a disguise are seldom well sustained, and the amusement afforded is consequently of a very indifferent and often of a very equivocal kind.

MASS. By the mass of a body is meant the quantity of matter which it contains, upon the supposition that differences of weight are always the consequence of different quantities of matter. This involves an hypothesis; for instance, if gold be, bulk for bulk, nineteen times as heavy as water, it is presumed that a given bulk of gold contains nineteen times as much matter as the same bulk of water. But it is possible that if we were better acquainted with the constitution of these bodies, it might appear that we are wrong in supposing difference of quantity to be the cause of difference of density.

The fact is, that mass means weight; so that of two bodies, the heavier is that which has the more mass: why, then, is this word introduced at all? If we had only to consider bodies at the surface of the earth, we might in all cases substitute weights for masses; but when we have occasion to speak of bodies at very different distances from the centre of the earth, their weight towards the earth, which is then called the attraction of the earth, depends upon their distance from the earth, as well as their absolute constitution. If we imagine two planets at the same distance from the earth, the attractions of the earth upon the two will then be in a proportion which depends, not on that distance, but on the amount of matter in the two planets.

When we say that Jupiter has only the 1047th part of the mass of the sun, we express—1, a fact of which observation and deduction make us certain, namely, that at the same distances the attraction of the sun upon the earth is 1047 times as great as that of Jupiter upon the earth; 2, an hypothesis of the following kind, that the sun contains 1047 times as much matter as Jupiter. The hypothesis is a convenience, not affecting the truth or falsehood of results; the fact represented remains, that at the same distances the sun does 1047 times as much towards deflecting the earth as is done by Jupiter.

In the application of mechanics, the following equations frequently occur:—

$$\text{Weight} = \text{mass} \times \text{force of gravity}.$$
$$\text{Mass} = \text{volume} \times \text{density}.$$

These equations, like others of the same kind, are to be understood with tacit reference to the units employed; they spring from the following proportions:—Any two masses are to one another in the ratio compounded of that of the volumes and that of the densities; thus the two bodies being eight cubic feet three times as dense as water, and seven cubic feet four times as dense, the masses are in the proportion of 8×3 to 7×4, or of 24 to 28. Again, if two different masses be acted upon by pressures which would, in a unit of time, create different amounts of velocity, the pressures are to one another in the ratio compounded of that of the masses and that of the velocities which would be generated in the unit of time. Thus if the preceding masses, which are as 24 to 28, were subjected to attractions which would produce in single particles velocities of 10 and 11 feet, if allowed to act uniformly for one second, the pressures requisite to prevent motion at the outset would be as 24×10 to 28×11, or as 240 to 308.

To convert these proportions into equations, let the unit of time be one second, that of volume one cubic foot, and let water be the substance which has the unit of density; also let the unit of length be one foot. Then, if the unit of mass be one cubic foot of water, and the unit of weight the pressure necessary to restrain a unit of mass acted on by an attraction which would, in one second, give a velocity of one foot per second, the preceding equations are true. [WEIGHT; SPECIFIC GRAVITY; ACCELERATION.]

MASS (*Missa*, in Latin). The derivation of the word "missa" has been variously accounted for; some derive it from missio or dimissio, "dismissal," because in the early ages of the church the catechumeni, or new converts who were not yet admitted to partake of the sacrament, were sent out of the church after the liturgy was read, and before the consecration of the Host. Others derive it from the Hebrew word "missah," that is, oblation or sacrifice in commemoration of the sacrifice of our Redeemer for the sins of mankind. Ducange, in his 'Glossarium,' art. 'Missa,' gives the various opinions on the etymology of the word. The word missa, signifying the ceremony or rite of consecrating the Host, is found in the epistles of St. Ambrose, St. Augustine, and Cesarius, bishop of Arles. See also Baronius, in his 'Annals.'

The mass is a church service which forms an essential part of the ritual of both the Roman Catholic and Greek or Eastern churches, and in which the consecration of the sacramental bread and wine takes place. The *canon of the mass* now used by Roman Catholics, was first compiled by Pope Gregory the Great, and it was long before it was adopted in all the Latin churches. In the 8th century arose the practice of *solitary masses*, performed by priests alone in behalf of souls in purgatory, but the practice was condemned by the church at a synod held at Mentz before the end of the century. This service is performed entirely by the officiating priest standing before the altar, and attended by a clerk who says the responses. The prayers of the mass are all in Latin in the Roman Catholic church, in ancient Greek in the Eastern church, and in Syriac among the Maronites and Jacobites, but never in the vulgar or vernacular tongue of the country. The congregation take no ostensible part in the service, but they follow it mentally or in their prayer-books, in which the text of the prayers is occasionally accompanied by a translation in the vulgar tongue. The priest does not address the congregation, but has his back turned to them, except at the end of certain prayers, when he turns round, and says, "Dominus vobiscum" ("The Lord be with you"), and at the "Orate Fratres," &c. ("Brethren, pray," &c.), which are responded to, on the part of the congregation, by the clerk. The mass consists of various parts:—1. The Introitus, or preparation, consisting of several prayers, psalms, the 'Gloria in excelsis,' the epistle and gospel for the day, the Creed, &c., which the priest recites with a loud voice. 2. The consecration, in which the priest consecrates the bread and wine, repeating the words, "Hoc est corpus meum, et hic est calix sanguinis mei," and then shows to the people both the bread and the chalice containing the wine, upon which all the congregation kneel down. 3. The communion. The priest, after reciting more prayers, accompanied by an invocation of the apostles and other saints, the Lord's Prayer, &c., takes the sacrament under both forms; if any of the congregation are disposed to take the sacrament, the priest then descends from the altar and administers it to them in the shape of the consecrated wafers or bread only. 4. The post communio, which consists of a few more prayers, and of the blessing which the priest gives turning towards the congregation, after which he reads the first chapter of the gospel of St. John down to the fourteenth verse, and the mass is over.

The low or ordinary mass, *Missa brevis*, lasts in general about half an hour, and every Roman Catholic is bound, by what are styled the "Commandments of the Church," to attend it once at least on Sundays and other holidays, unless prevented by illness. The transgression of this precept is reckoned a sin. Pious persons hear several masses in succession, and many attend mass every day in the week, for it is celebrated every day in each parish church. A priest must not break his fast either by food or drink from the previous midnight until he has said mass, out of respect for the real presence of Jesus Christ in the sacrament. The service of the mass is indeed essentially connected with and depends on the doctrine of transubstantiation. [TRANSUBSTANTIATION.]

On great festivals and other solemn occasions the mass is performed by a priest or prelate, attended by a deacon and subdeacon, who says the responses and chants the epistle and gospel of the day. On those occasions the mass, or at least parts of it, are sung by a choir, accompanied by the organ and other musical instruments. This is called "high mass," and is a long and pompous service. Palestrina, Mozart, Cherubini, and other among the most celebrated musicians, have produced most beautiful compositions for this service. Both for the low and the high masses the officiating priest is dressed in peculiar various-coloured garments appropriated to the occasion, which he afterwards takes off in the vestry-room.

The 'Missale' is the name of the book which contains the ritual of the mass, and which the priest holds open before him on the altar. Some of the old Missals, whether MSS. or printed, are beautifully ornamented with paintings, and are valued as bibliographic curiosities.

The Protestant and reformed churches have no mass, as they do not believe in the doctrine of transubstantiation; but several of the detached 'Oremus,' or prayers of that service, which are very fine, have been retained in the Liturgy of the Church of England, translated in the vulgar tongue.

MASSA'GETÆ, an ancient people of central Asia, in an expedition against whom Cyrus is said to have lost his life. ('Herod., i. 205-216; 'Justin.,' i. 8.) Alexander also met them in his expedition to Sogdiana, B.C. 328. ('Arrian,' iv.) Herodotus says that they lived north of the Araxes, by which he probably means the Jaxartes (i. 201), and on the plain to the east of the Caspian Sea: this would include the country now known as Sungaria and Mongolia, extending to the base of the Altai mountains. According to Strabo, the Hyperborei, Sauromatæ, and Arimaspi dwelt above the Euxine, the Ister, and the Adriatic; and the Sacæ and Massagetæ above the Caspian (p. 507, Casaubon); and a little further he remarks that the Massagetæ were to the east of the Daæ, who bordered on the Caspian Sea (p. 511).

Herodotus was in doubt whether the Massagetæ ought to be reckoned among the Scythians (i. 201); but they were usually regarded as part of the Scythian nation by succeeding writers. ('Arrian,' iv. 17; 'Pliny,' *H.N.*, vi. 19.) Strabo (xi.) details some of the inhuman customs of the tribe; which lead Niebuhr and Birkh to consider the Massagetæ as a branch of the Mongolian race; while Humboldt ('Central Asia') believes them to have been of the Indo-European stock. The similarity of their name (*Massa-getæ*; compare *Tyri-getæ*, *Thyssa-getæ*) might lead to the supposition that they were connected with the Getæ of Europe.

The Massagetæ are described by Herodotus as a numerous and powerful nomadic people, who resembled the Scythians in their dress and mode of life. Gold and silver were plentiful among them, obtained no doubt from the Altai range; but no iron or silver was found in their country. They were however in a very low state of civilisation, even for a nomadic people. They had a community of wives; and their aged people were killed and eaten by their relations.

MASSICOT. [LEAD.]

MASTER AND SERVANT. [SERVANT.]

MASTER OF A SHIP. [SHIPS.]

MASTER OF ARTS. [ARTS.]

MASTERS IN LUNACY. [LUNACY.]

MASTIC. A name given by manufacturers to the oleaginous cements which were formerly used to a great extent both at home and abroad, but which lately have been entirely neglected. The normal composition of these materials appears to consist of a mixture of about 7 parts of litharge (the red protoxide of lead), with 93 parts of burnt clay, ground to a very fine powder, and applied by ordinary plasterer's tools, after being mixed with a sufficient quantity of pure linseed oil to reduce the mass to a tenacious plastic state.

The best mastics were formerly considered to be the Hamelin's mastic, in England, and the mastic de Dhil in France; the former material was largely used in King William Street, City, but it was far from successful, and very costly.

MASTICH, commonly but improperly termed gum mastich, is the produce of the *Pistàchia lentiscus*, var. *Chía*, a small tree, native of many of the shores of the Mediterranean and islands of the Archipelago. In the island of Scio much attention is paid to the collection of it. About one-third of what is there obtained belongs to the Pasha, and constitutes the fine sort called seraglio mastix, mostly sent to Constantinople. Between the 15th and 20th of July slight incisions are made transversely in the stem and larger branches, whence flows a resinous juice, which gradually thickens, and either adheres or drops on the ground. That which remains attached is removed by an iron instrument, and is collected between the 24th and 31st of August. Two gatherings occur in this space of time. What remains after the tribute to the Pasha is deducted yields two sorts, the so-called seraglio kind, and a second, chiefly sent to Egypt. A third sort is sent to European markets; and of late the finest kind also reaches our marts. This occurs in small isolated pieces, called *tears*, seldom so large as a common pea, from attrition covered with a white dust, nearly transparent. Mastich in sorts has various impurities, and is sometimes mixed with sandarac.

Pure mastich has a mild, agreeable odour, and an aromatic taste; by chewing it softens, and becomes sticky or adhesive. With a gentle heat it melts; ignited, it burns with a strong balsamic odour. It is not at all soluble in water, but is soluble to a great degree in alcohol, and entirely so in ether and fixed oils. Its chemical composition is a very small quantity of volatile oil, and two kinds of resin: one, to the amount of 90 per cent., soluble in alcohol, possessing acid properties, hence called mastich acid; and another, to the amount of 10 per cent., insoluble in alcohol, called mastichine, considered by Bonastre to be a subresin.

Mastich is chewed by females in the East, to sweeten their breath and strengthen their gums; in Europe it is used as a dentifrice, and to stop decayed teeth. It is also an ingredient in pastilles, and perfumes, such as eau de luce. But its chief employment is as a spirit-varnish.

MATCH, in gunnery, is a material employed in firing military mines or in discharging pieces of ordnance. Before the invention of fire-locks, hand-guns or small-arms were fired by matches, which the soldiers carried with them on service; and match-lock fire-arms are still used in some parts of Asia.

What is called *slow-match* is only a piece of slightly twisted hemp which has been well soaked in a strong solution of saltpetre with boiling water. When fire has been communicated to it, it burns very slowly, and a piece one yard long is scarcely consumed in eight hours. In use, the end to which fire has been applied is blown upon by the breath, when it is capable of setting fire to gunpowder or to the cotton-wick inserted in the composition which fills a fuse.

The materials employed in the formation of *quick-match* consist of a mixture of saltpetre and mealed gunpowder with spirit of wine and rain-water. The water in which the saltpetre is put, is made to boil for an hour in a copper vessel, a wick of cotton being coiled in the liquid; the alcohol is then added, and the mixture is allowed to simmer over a slow fire for a quarter of an hour. Some of the powder is afterwards introduced, and the whole is left during twenty-four hours. The cotton is then wound on a reel and the remainder of the powder is sifted over it. The match is then left for several days in order that it may become thoroughly dry, after which it is fit for use.

MATCHES; CONGREVES; LUCIFERS. The manufacture of these humble and cheap articles marks a curious stage in the progress of civilisation, where luxuries become conveniences, and then necessaries. The friction of two pieces of dry wood we now regard as a barbarous mode of procuring light; yet it is a scientific one, where the materials for a quicker process are wanting. The flint and steel had a long reign in this country; the tinder-box formed an item in Wolverhampton manufactures; and the sulphur-tipped matches, arranged in bunches spread out in fan-like manner, formed the stock in trade of many an itinerant dealer. As mechanical ingenuity supplied the flint and steel and tinder-box to supersede the rubbing sticks, so has chemical ingenuity made a wide step in advance, by showing how to furnish the little splints or matches with a composition which will kindle by slight friction.

Whether called *Congreves*, *Lucifers*, or *Instantaneous Lights*, these small but valuable articles are now made in almost inconceivable quantities. Hand cutting has long been unable to produce the splints in sufficient quantity; nothing less than steam power can do this. At one among many saw-mills in London, these matches are made in the following way. The wood employed is American yellow pine. It is first sawn into blocks about 12 inches long, 5 or 6 wide, and 3 thick. Several of these blocks are placed in a machine where a number of revolving cutters, worked with great rapidity, slice the blocks up into layers, and cut the layers into splints. One machine will cút up two million splints in a day. The splints, as liberated from the machine, slide down into another room, where women and girls tie them up in boxes, the boxes in parcels, and the parcels in bundles. These splints are sold by the *hogshead* to the lucifer match makers, each hogshead containing perhaps two million splints. At one saw-mill alone, it is estimated that the timber of four hundred large pine trees is cut up yearly for lucifer matches; and there are some establishments in England where as many as *five million* splints are made in a day. If the splints are to be cylindrical instead of square, the wood is shaped by being forced through small circular apertures in a metal plate: great pressure, and great sharpness at the edges of the holes, being necessary. But Germany exceeds even England in this branch of industry, as in most other kinds of wood-work. In Saxony, undipped matches, two inches in length, can be bought for 5 thalers per million, about 1400 for a farthing; and boxes to contain them are sold at 2*d*. per 100. At various places in Bohemia, untipped splints are sold wholesale at a price that scarcely amounts to one farthing per 3000; and at Schüttenhofen tipped matches, boxes and all, containing 80 matches in each box, are sold at the rate of about one penny for a dozen boxes. This degree of cheapness was attained in 1851; and it is likely that prices have lowered rather than risen since.

The chemistry of matches has undergone curious changes. At one time *phosphoric tapers* were made,—complex, dangerous, and expensive. These were supplanted by *phosphorus bottles*, in which sulphur matches were ignited by contact with a bit of phosphorus. A more scientific but less-used arrangement was the *pyrophorus*, in which light was produced by exposing to the air a calcined mixture of flour, sugar, and alum. The *instantaneous light* of Volta was an elaborate apparatus for producing light by the action of electricity upon hydrogen. *Dobereiner's* instantaneous light was a little less complex than this. The *light-syringe* was a kind of squirt, which ignited a piece of German tinder by means of the heat expelled from air when powerfully condensed. All of the above were superseded, for popular use, by the *oxymuriate matches*. Chlorate or oxymuriate of potash was mixed into a paste with gum and vermilion; matches were tipped with this composition; and when the tipped end of a match was dipped into a bottle containing a bit of asbestus moistened with sulphuric acid, it instantly ignited. Elegant metal boxes fitted with this apparatus had a very extensive sale for many years, at prices which gradually fell from a guinea to a shilling. It was not until friction was rendered adequate to the kindling of a match, that the principle of cheapness came fairly into play, by allowing the makers to dispense with liquids, bottles, and complicated arrangements. The *congreve* vanquished all competitors as a light-giver. The chemical composition which gives to the matches their easy-igniting power, can now be bought at a very low price; and as children are chiefly employed in the manufacture, the matches can be sold extremely cheap. Whether the colour be red, yellow, brown, blue, or green, the composition possesses the requisite quality in respect to ignition by friction; and chemists are now acquainted with many such. There are many processes and compositions adopted. In one, the matches are dipped into a mixture of phosphorus, oil of turpentine, and flowers of sulphur; and afterwards into a mixture of gum arabic, chlorate of potash, and soot. In a second method the composition consists of chlorate of potash, phosphorus, gum arabic, and gelatine; the matches being dipped into melted sulphur before being dipped in this composition. In a third method, the composition consists of gum arabic, vermilion, phosphorus, and saltpetre. *Chlorate matches* are dipped into a mixture of chlorate of potash, flowers of sulphur, powdered sugar, gum arabic, and vermilion. The dipping of the end of the splint into melted sulphur, and then into a melted composition of which phosphorus is one of the ingredients, is a very dangerous employment, which has led to many sad calamities. It is also found that the phosphoric fumes tend to induce jaw-diseases, and other maladies, under which the work-people suffer. There is a kind of phosphorus, called amorphous or allotropic, which is said to be free from many of the evils of common phosphorus; but various circumstances have prevented its introduction to any great extent in the match manufacture.

MATE'RIA ME'DICA is that branch of medical science which treats of the articles employed in the practice of medicine, and embraces an explanation of the nature and modes of action of those substances which are had recourse to in order to restore the healthy state of the human frame when its functions or structure are impaired by disease. Thus defined it comprehends both pharmacology and therapeutics. The former means an account of drugs, simple or prepared, in reference to their physical character, natural history, commercial history, chemical composition, and modes of exhibition. The latter means an exposition of the principles which should regulate their employment. The pharmacological part of the subject is sufficiently treated of under each article, as it presents itself in alphabetical order, and it is only requisite to treat here of the general principles involved in their practical application. For the full and satisfactory comprehension of this department, a previous knowledge of the structure of the body, or anatomy, and, above all, of general anatomy, and of the respective duties or offices performed by its component organs while in a state of integrity, or physiology, and of the various degrees of departure from these, when from any cause they become deranged in their action, or pathology, and the signs by which the morbid states are indicated, or nosology, is required. These departments of science are studied only by those persons who intend to follow the medical profession, and at their hands only can a skilful employment of medicines be expected. Something however may be done for the advantage of the public by pointing out how medicines act, and in what way they prove remedial. The object of the administration of a medicine is to arrest the progress of diseased action, and to remove the consequences of its existence, that is, to restore the individual to perfect health, such as he enjoyed before the organ or organs received the impression of the morbific cause; or where both or either of these objects cannot be accomplished, so to retard the career of the unhealthy operations, as to prolong life to the latest possible period. To improve and perfect this most important branch of the healing art is the end and aim of all the other branches of medical science. The means of accomplishing this object have varied in the different stages of human civilisation, and according as different theories of the nature or cause of diseases have prevailed. Many of the medicines formerly in use were of a disgusting or repulsive nature, or of a kind devoid of any active principle, and therefore inert. Many also owed their introduction into practice to superstition, credulity, or a misapplication of the principles of natural and chemical philosophy, and have long been discarded by scientific practitioners, though frequently retained by the populace or by quacks. The medicines used in the present day are still drawn from all the three kingdoms of nature, though the animal kingdom yields few, the vegetable kingdom a considerable number, and the mineral kingdom the greatest number and generally the most active.

In general few articles produce much effect on the human frame, either in a state of health or disease, which are not possessed of marked sensible qualities, impressing the senses of smell or taste in a distinct manner. Hence bland insipid articles are mostly better fitted to furnish nourishment than medicines, being completely digested, and creating no disturbance or change of action of the vital powers of the system; medicinal substances on the contrary do not appear to be thoroughly digested, but a portion remaining unassimilated acts in some measure as a foreign body, and produces a stimulant or alterant effect on the vital power. Many medicines are indeed absolutely poisonous if given in large doses, or where no diseased state of the system requires their administration. For disease often gives to the system a power of sustaining the action of a dose of medicine which would produce serious disorder if given to a person in health; the morbid state of the system seeming to act as an antidote to the medicine, while the medicine acts as an antidote to the disease—health being the result of their neutralising power.

Medicines produce two distinct effects: one termed the primary, or in some cases, as when given to a healthy person, the physiological effect; the other secondary, or curative, which can only take place when there exists a disease to be removed. The former is generally uniform or constant; the latter too often variable and uncertain. To lessen the degree of uncertainty in the latter and most important of the two kinds of action, many zealous medical men have instituted experiments with different medicines on themselves or others; while chemists have carefully investigated the chemical composition of the articles, and sought to discover their active principles, or to explain their modes of action. Notwithstanding these valuable aids, therapeutics is still the most imperfect of all the departments of medical science, partly from the difficulties inherent in the subject, and partly from inability in medical men to weigh correctly the evidence respecting the effects of medicines. The union of several articles in one prescription, by which we attempt by one stroke to remove several symptoms, tends still further to obscure the results, and to vitiate the conclusions which may be drawn. The polypharmacy of the ancients has been in a great measure abandoned, but still it must be confessed that simplicity in prescribing is not sufficiently studied. (Holland's 'Medical Notes and Reflexions on Medical Evidence, and on Methods of Prescription.') On the opposite hand, the attempts to isolate the supposed active principle of many vegetable remedies, and to administer it apart from the others, though in some instances advantageous, by diminishing the size of the dose, or concealing the unpleasantness of the taste, have not produced the consequences expected; for example, in most cases *cinchona bark* administered in some of the old preparations will be found a more valuable tonic than *quinine*. The superiority of many mineral waters, which contain a variety of ingredients in a state of extreme dilution, over the exhibition of the saline materials in a less quantity of liquid, seems to militate against the practice of excessive concentration.

The introduction of new substances into the Materia Medica, by the discovery of new plants, or by the progress of chemistry, may supply deficiencies in the catalogue of remedies. But less benefit to mankind will flow from a multiplication of remedies, than from the establishment of clear and scientific rules for their administration. Every improvement in anatomy and physiology will promote the advancement of therapeutics, by leading to greater precision in the employment of medicines. For nothing is more certain than that medicinal substances act upon special parts of the body, in preference to others, and in many instances on those which are diseased rather than on those which are sound. The careful investigation of the modes of action of medicines is worthy of the best faculties and energies of medical men, and every contribution to this department of science should be regarded as an incalculable benefit conferred on mankind.

(Pereira's *Elements of Materia Medica;* Vogt. *Lehrbuch der Pharmakodynamik*, and Headland *On the Actions of Medicines*.)

MATERIALISM is a name applied to any philosophical system which denies the existence of a spiritual or immaterial principle in man, called the mind or soul, distinct from matter, or which (changing the phrase) denies the immateriality of the soul. The name is applied to systems which differ very widely from one another, in respect of the consequences deduced from the denial of the soul's immateriality; and thus it comes to pass that the popular meaning of the word has become loose and incorrect, comprehending what are no better than accidental consequences of the pure and proper idea. Such accidental consequences are the denial of a future state and absolute atheism; and it need not be said that atheism and materialism are treated in current conversation as convertible expressions.

The name materialism also is one of that sort for which Mr. Bentham has constructed the epithet *dyslogistic.* As applied in current conversation, it always carries with it censure. This arises, of course, from the nature of the accidental consequences which have been indicated, and which mankind regard with horror; but inasmuch as the name still continues to be applied to systems from which unchristian and atheistical consequences are expressly excluded, and even to some systems (such as that of Hartley) which admit the existence of a separate soul, but in whose method of explaining mental phenomena there is a dash of materialism, the censure that has come to be indissolubly associated with the name often falls with grievous injustice. Indeed there is hardly a single word in the whole range of philosophic terminology better fitted to exemplify the evils of looseness of application, or of allowing feelings to tinge and discolour the notions conveyed by names.

The systems to which the name materialism is applied may be roughly distributed under a threefold division. First, it is applied (as has been already said) to a system like that of Hartley, which admits the existence of a soul, but which, attempting to explain mental phenomena physically or by movements arising out of the bodily organisation, seems to imply materialism. Secondly, it is applied to the systems of Hobbes and Priestley, and of the French school of writers, of which De la Mettrie may be taken as a specimen, which distinctly deny the existence of a soul as a separate principle in man, but which do not deny either a God or a future state. In the systems of these writers is evolved the pure and proper idea of materialism, divested of all unnecessary consequences. Thirdly and lastly, the name is applied to systems like that of the ancient Epicureans, which deny both a future state of rewards and punishments and a Divine Creator, systems for which atheism would be the better name, inasmuch as materialism fails to denote their more important and distinctive ingredients.

The following is a brief summary of the views of Dr. Priestley, who has more formally than any other writer enunciated the principles of materialism in the pure and proper sense of the word. He denies the existence of a separate immaterial principle in man, called the mind or soul, because he thinks that an immaterial principle could not exist in union with the material body, and because he thinks, further, that all mental phenomena (as they are called) may be explained by means of supposed movements arising out of the bodily organisation. The method by which he thus explains mental phenomena is that of Hartley. [HARTLEY, in BIOG. DIV.] Adopting this philosopher's hypothesis of medullary vibrations, he defines mental phenomena as medullary vibrations perceived; and he contends, principally from the analogy of brutes, that bodily organisation is adequate to produce perception. Thus, and by means of such hypothesis, does he dispense with the hypothesis of a separate immaterial soul. But, denying the existence of a soul, separate from the body, and capable of surviving when the body perishes, he does not yet deny the immortality of man, and a future state of rewards and punishments. On the contrary, he distinctly affirms these on the authority of Scripture. It is needless to add that Dr. Priestley does not deny the existence of a God. [PRIESTLEY, in BIOG. DIV.]

One word more on the absurdity of coupling the denial of a future state with the denial of an immaterial soul, and of making atheism synonymous with materialism. To deny a material soul is necessarily to deny an immortal soul, but not therefore to deny an immortal man. And even to deny the existence of everything save matter in the universe, is not necessarily to deny a Divine principle, as is shown by many of the ancient schools of philosophy [ELEATIC PHILOSOPHY], nor even to deny a moral governor, as is shown by the philosophy of Hobbes, who, denying in one part of his writings the existence of all spirit, and in this respect carrying his views further than Dr. Priestley, yet makes God the corner-stone of moral and political science. [HOBBES, in BIOG. DIV.] Hobbes distinctly says that there being nothing, in his opinion, but matter in the universe, it follows that God is matter.

But it is to be remarked, in opposition to materialism, even as it is put forth by Dr. Priestley, that it is devoid of philosophical foundation, and rests on a disregard of the limits of true philosophy. Its truth cannot be tested by observation. It rests altogether on hypothesis and conjecture. When we go beyond what are called the qualities of the mind, or of matter either, and speculate upon what it is itself, whether it is something else, or different from that something, whether it has or has not an existence, we have no help but in supposing and conjecturing and imagining. Such speculations may doubtless be interesting, and they may have their use too as an exercise for the imagination, but we cannot calculate upon their results. Much mischief is done, moreover, by mixing up these results with the results of observation, by jumbling together conjecture and philosophy. The true philosopher, not despising, but setting aside as irrelevant to his object, all speculations on the origin and nature of mind, or of matter either, will start from these as first principles, and will apply himself to observing their qualities and capabilities and laws; and the results will be sound psychology and sound physics.

The converse of the word materialism is immaterialism. This is used only as an abstract term, and even thus very seldom, spiritualism being generally used in its place.

MATERIALS FOR BUILDING. In some of the previous articles reference has been made to the conditions which should regulate the application of particular building materials [ATMOSPHERIC INFLUENCE; FOUNDATIONS; MASONRY]; but the leading principles connected with their selection, and the mode of their applications, are of such paramount importance to all parties connected with this branch of the constructive arts, that it appears desirable to allude, in general terms at least, to their nature. The manner in which this will be done will be by noticing, in the usual order, the materials used in the various details of a building.

External walls (which are mainly required to resist the transmission of moisture from the ground upwards, or from the exterior to the interior of a building, and to maintain an equable temperature in the interior if possible,) may be constructed of either stone, brick, or wood, according to local circumstances; provided the requisite precautions be taken to guard against the destructive action of humidity, or against the various mechanical efforts exerted, and that there be no danger from the propagation of fire, in cases where many buildings are in proximity to one another. The stone may either be used in large or small rough blocks, devoid of bedding or of regular vertical joints; or it may be used in the form of coursed masonry in the manners described under that head; and the only general principles it may be desirable here to allude to with respect to the use of stones of various descriptions, are, that such of them as are dense and of small absorptive powers should be used near the ground; whilst the use of the lighter and the more hygrometric ones must be confined to the positions where they will not be exposed to great efforts of compression, or to external sources of moisture; and care should be taken that the stones are in no case laid with their planes of bedding otherwise than in the direction which they may have occupied in the quarries. The various descriptions of stones (such as the granites, whin stones, slates, marbles, carbonates, argillo-carbonates, and sulphates of lime, and the magnesian limestones) have already been alluded to in the articles quoted, or they will be finally discussed under that of STONE; so that, for the present, it may suffice to say that any material of this description may be advantageously used for building purposes when it is uniform in its grain, or in its molecular structure; when it has comparatively small powers of absorbing water; and when it is not a very ready conductor of heat. The latter condition is too often neglected, and it is on this account that many of the buildings in cold, moist, countries, present hygienic properties of a very dangerous character; for the condensation and the evaporation which are thus continually going on, must render latent a great amount of heat furnished by surrounding objects. The absorptive powers of stones have an important bearing, not only upon the comfort of the interior of the buildings in which they are employed, but also upon their durability, on account of the disintegration and decay which attends the evaporation of the salts they are able to liberate from their original combinations in the stones. It appears, however, that the mere fact of the existence of great powers of absorption does not constitute an absolute reason for the rejection of a building stone; because there are some materials of this class which are of great constructive value, but which are highly absorbent; such as the Yorkshire sandstones, and some of the silicious conglomerates. The structure of a stone has a marked influence upon its powers of resistance to natural external causes of decay, and it is found that the more highly crystalline materials are the most durable; whilst those in which the molecules of the stone are both of an earthy and of a decidedly marked sub-crystalline character (as is often the case with the inferior varieties of the oolites), are sure to decay in an irregular manner. Some descriptions of granite even are exposed to decay in the open air, on account of the differences in the molecular structure of their constituent elements.

Many of these remarks will apply to the choice of bricks for building purposes; for their relative values will depend upon their powers of resisting the transmission of water, their non-conducting powers, and their durability under the ordinary action of the atmosphere, when exposed for a long time to its effects. In many cases walls have been, and still are, executed of unburnt clay, either rammed into moulds which enclose the space to be occupied by the wall itself (in the manner used in the western counties of England, where it is known by the name of *cobb walling*), or in the form of unburnt bricks (as in the walls of Assyria and of parts of Egypt), and when due precautions are taken to isolate the lower parts of such walls from the ground, and to protect them from heavy rains, they certainly make very warm and comfortable even though temporary structures. The total disappearance of the domestic structures of the nations of antiquity which adopted the use of unburnt clay, whilst the structures erected at the same period of the more durable burnt bricks have survived to our times, prove (if such proof were needed) that the latter alone should be employed in buildings which are likely to be long exposed to distinctly marked atmospheric influences. In fact, no mere mechanical preparation of the silicates of alumina (the base of all clays) can give those materials the property of a permanent cohesion; and no stable combination between the various elements can be effected, without the intervention of fire; or, in other words, the pyrogenous combination of silica and alumina are the only stable ones. A small proportion of the carbonate of lime in clays is a desirable condition; for it facilitates the fusion of the other ingredients; but a large proportion of carbonate of lime entails inconveniences which have already been alluded to. [Brick.] It may be suspected that much of the value of brickwork depends upon the reaction of the bricks themselves upon the mortars, or upon the cementing materials employed; and it would therefore seem that, for the purposes of hydraulic engineering, or of building in water, it is desirable to use bricks which, even after calcination, retain a certain proportion of soluble silica, in a state to allow of its being taken up by the lime around it. The remarkable preservation of the underburnt Roman bricks, or of the soft kiln-burnt bricks of the middle ages, when used in positions where running waters could not affect them, may be explained by the fact of the existence of some statical chemical balance of this description. For general purposes however, it may be sufficient here to state that the hardest, and most thoroughly burnt, bricks only ought to be used in the exposed faces of walls; that only the best hydraulic limes [Lime; Mortar] should be used in conjunction with them; and that, without entering into any abstract calculations of stability, no external walls of houses *in exposed positions*, should ever be constructed of less thickness than of one and a half brick; so as in fact to intercept the passage of water from the exterior to the interior by a vertical joint of mortar. The combination of brickwork and of timber sometimes admits of the attainment of the latter condition, when the total thickness does not exceed that of one brick; but in this case the bond of the work cannot be theoretically satisfactory.

In many of our colonies, and in many well wooded countries of a more ancient date, the use of timber for external walls takes place to a great extent; nor, provided that the passage of moisture from the ground, by capillary action, be intercepted, that the rain be prevented from lodging on the upper surfaces, and that there be no danger from the communication of fire, can there be any rational objection to this mode of construction. Where wood is very abundant, as in the United States, Norway, &c., it is used simply in logs; and those logs are laid upon one another without being squared, but are only halved together at the angles; the interstices are then filled in with clay, or with lime and hair; and the exterior and interior surfaces of the walls thus formed, are then carefully plastered. In countries where wood is more valuable, the style of construction becomes more elaborate, and the framing is executed with squared timber, either filled in with brickwork-panels, called technically "brick-nogging," or with quarterings, which are subsequently either covered by "shingles," (or small thin-pieces of wood laid like slates,) or are boarded, or lathed and plastered. The half timbered houses in our own country, and in Normandy, may be referred to as illustrations of all these last named varieties of wooden construction; and of the remarkably picturesque effects they were able to produce. The Swiss *châlets* of the present day are equally worthy of admiration; and it may be worth while to add that when the exposed timbers of such half timbered houses are covered by slates, as is very frequently the case in our own southern provinces, they are but little exposed to the danger of decay, or of fire; but no such palliations of the defects inherent to wood structures can ever guarantee them against the attacks of insects or of vermin.

The principal use of wood is, however, for internal works and fittings; and the selection of the particular description to be used in any position must be regulated by so many local considerations that it is preferable to treat of them in two separate articles. [Woods, Building; and Woods, Furniture.] The general conditions for their selection and use are, that the woods should be as light and as easily worked as possible, consistently with the requisite degree of strength; that when intended to be used as girders, or for framed carpentry, they should be of a straight, tough, fibrous nature; that the trees should be felled in the winter, and that, under all circumstances, the wood should not be fixed in a building until the sap, or other moisture it might contain, had been allowed to escape; that a free circulation of air should be maintained around the woodwork of every description; and that especially all contact with a damp, confined, atmosphere should be avoided. As might naturally be expected, woods transmit moisture more easily in the directions of their vesicles, than transversally to the latter; and attention must be paid to this law whenever it may be necessary to employ this material partially in and out of the ground. The attacks of insects, and of the marine boring worms, together with the conditions of decay under the action of wet or of dry rot, must not be overlooked in the inquiry into the value of woods; they are discussed under Preservation of Stone and Wood. A very essential property in woods used for decorative works is that they should not be exposed in any serious manner to absorb atmospheric, or in fact any external, moisture; and that they should not warp under changes of temperature. To a certain extent, all woods are exposed to this inconvenience; but the superior descriptions of mahogany, oak, and fir, do not warp in any serious or dangerous manner under ordinary changes, provided that due care has been observed in their seasoning before placing them in the work. Some woods again have a distinct action upon metals, such as the oak produces upon iron, or even occasionally upon lead; but the circumstances under which this action takes place are not sufficiently known to warrant any decided general observations with respect to it. Contact with other building materials does not seem to affect the durability of wood, provided the circulation of air around the latter be not prevented.

It is rather a curious illustration of the practical working of injudicious fiscal laws, that the use of timber in external house construction should have prevailed in such places as Caen, where stone is to be procured at the very gates of the town; simply because in the middle ages there was a heavy octroi, or toll, on building stone. Many local peculiarities in the use of building materials may, no doubt, be explained in the same manner; as, for instance, the peculiar size of English bricks, or the Mansard roofs of France.

The materials used for covering the rough surfaces of walls, or for producing a smooth surface upon framed timber partitions, are either obtained from the calcination of the carbonates of lime, of the various classes of cements, or of the sulphates of lime; and the same class of materials is, as is well known, largely applied for the purpose of connecting the small materials used for walling. The respective qualities of the Limes, Mortars, Cements, and Plasters will be found under those heads, so that it may suffice here to say that, in consequence of the greater rapidity with which the real plaster (the dehydrised sulphate of lime) sets, it is always employed internally to *render* or cover the walls or partitions, when that can be done economically. It is required, in such cases, to produce an even surface to receive the wall decorations, which surface should at the same time be so far absorbent and non-conducting as not to allow the moisture in suspension in the rooms to condense upon, or to remain upon, the sides of the rooms; and for this purpose the real plasters possess properties which no other materials can boast of. In the greater part of Europe, however, plaster is both rare and costly, and its place is supplied, more or less satisfactorily, by the lime and hair, and the fine stuff, as our plasterers designate the various descriptions of coats they obtain from the purer carbonates of lime treated in peculiar manners, according to the particular parts of the operation. The hydraulic cements are sometimes used for internal plastering or wall decorations, when moisture is to be contended with; and the oddly named artificial cements obtained by the second calcination of the sulphates of lime, such as the Keene's, Parian, or Martin's cements, are used for skirtings or for wall decorations, when particularly hard close surfaces are required, and it may be necessary to paint them immediately. The plasters do not resist the action of the external atmosphere, or its changes of hygrometric state, although when proper precautions are taken the plaster of Paris stands tolerably well on external walls near that town; but, as a general rule, none but the hydraulic cements should be used for this particular description of work, and even with them it is essential to prevent moisture from lodging upon their surfaces, especially in climates exposed to sudden frosts and to heavy winter rains. Nearly all this class of materials requires to be protected by a coating of oil-paint, or of some other preparation able to oppose the absorption of water.

Roofs are covered in various ways, depending mainly upon the economical conditions of the locality,—namely, either by thatching with straw or reeds, by shingles, by tiles, by slates, or by one or other of the metals, iron, zinc, copper, lead, or tin; and, in very temporary buildings, even by tarred felt. Thatching makes a warm and an exceedingly picturesque covering; but it is objectionable on account of its retaining moisture under some circumstances, of its weight, and of its inflammable nature. In America and in Norway small wooden slabs, cut like slates, are used, under the name of *shingles*, and if properly nailed and weighted down in positions exposed to violent winds they answer tolerably well, though, of course, they are exposed to the same objection as the one above alluded to—namely, their inflammability. Shingle roofs were formerly common in England, and specimens yet remain on some church spires. In all densely peopled districts, therefore, slates or tiles are used for the commoner descriptions of houses, and the metals are used for more important buildings under the conditions discussed under Roof. The precautions to be observed in all these cases are—1, that an efficient circulation of air should be kept up within the roof; 2, that when metals are used, the contraction and expansion should not be interfered with; and 3, that when two metals are employed, they should be placed in such manner as not to allow a destructive galvanic action to take place.

Metals are also used in building operations in other modes than simply as coverings, and iron in its various forms has of late become an article of the greatest importance to the constructive or to the decorative builder. Cast-iron is largely used for girders, columns, railings, pipes, sashes, &c.; wrought-iron is becoming daily of more and more importance for girders, for roof framing, for pillars, railings, tanks, doors, and countless purposes of common life. Lead, copper, zinc, tin, and their alloys are used for many details of building, and for the distribution of those essential elements of modern comfort, gas and water: precautions, however, are requisite in their application to secure them from certain chemical actions which may be produced by the extraneous matters contained in the fluids so distributed. [Water Supply.] It would appear that if the new metal aluminium were obtainable at a cheap rate, it would constitute one of the most valuable additions to the list of building materials, on account of its lightness, its tenacity, and its powers of resisting the action of the atmosphere.

Glass in its various forms is a material so generally known that it will be sufficient merely to mention it; and the use of oil-paints for purposes of decoration or of preservation will be discussed under Paint. The use of the solutions of silica, and of the other various substances applied of late years for the protection of woods from wet and dry rot, will be noticed under the article Preservation of Stone and Wood, already referred to. Wall linings, or Paper Hangings, will be noticed under the latter head.

MATERIALS, STRENGTH OF. The strength of any material object, as a rod, bar, beam, chain, or rope, is that power by which the substance resists an effort to destroy the cohesion of its parts. It evidently depends on the disposition of the particles relatively to each other, on the intensity of the force by which the particles cohere together, and on the manner in which the straining power is applied. The inquiry into the laws by which the materials employed in the construction of edifices or machines resist the strains to which they are subject is of considerable importance, because upon a just adaptation of the strength at any one point to the strain there experienced (and an excess or deficiency of the former is sometimes equally injurious) depends the stability of the whole structure.

Whatever be the constitution of a rod or of a beam, the relation between its strength and the strain to which it may be exposed can be made the subject of mathematical investigation only by imagining the material to consist of an infinite number of particles arranged in lines (like fibres or threads) parallel to each other in the direction of its length. The particles in each line must be supposed to cohere together by powers exerted in that direction, and the several lines to cohere laterally with forces which may or may not be equal to those exerted longitudinally. In homogeneous bodies, as glass and some of the metals, the particles may be supposed to be symmetrically disposed throughout the masses, and to attract each other in every direction with equal powers: but the case is different in other bodies, particularly in timber; for in such bodies the lateral cohesion of the fibres is much less powerful than the longitudinal cohesion of the particles in each fibre. In ropes the fibres have no lateral cohesion, and the strength depends on the twisting of the fibres together; in consequence of this, as the latter can scarcely be separated from each other in the direction of the length of the rope, the cohesion of nearly all the particles in any transverse section must be destroyed before a disruption can take place.

A rod of any material, consisting of parallel fibres as above supposed, being placed in a vertical position, and strained by a weight applied at the lower extremity, the particles in every fibre will be separated from each other by the action of the weight, and consequently its length will be increased. The cohesive power by which the particles are kept together will, in most cases, be diminished by the separation; and if the weight be sufficiently great, or if it be allowed to act during a sufficient length of time, the cohesive power will be eventually overcome; that is, the rod will in some parts of its length be torn asunder. But before this occurs, since all bodies possess a certain degree of elasticity, on removing the weight the attraction of cohesion will cause the separated particles to return towards their original positions; or the rod will become nearly of the same length as at first. That it does not exactly become so, in general, arises from the imperfect elasticity of the material, on which account the particles come to a state of rest at augmented distances from each other. The elongation of the rod when strained by a weight, and the amount of the weight necessary to produce fracture, will depend on the nature of the material; and, from a want of uniformity in the constitution of materials even of the same kind, though the rods be of like dimensions, great irregularities are found to exist in their power of resisting direct strains. Numerous experiments performed on each of the different kinds of material can alone afford a mean value on which reliance may be placed when it is required to determine the capability of a bar or beam to resist the strain arising from the action of any given force.

If the materials were perfectly elastic, so that the length of the rod became the same after the removal of the suspended weight as before that weight was applied, the force of cohesion would evidently be proportional to the intensity of the straining power; and this is generally adopted as an hypothesis in investigations concerning the equilibrium between strengths and strains; it being understood that the latter have only that moderate degree of intensity, compared with the former, which is consistent with the permanent stability of the edifice or of the machine. The law just mentioned appears to have been discovered by Dr. Hooke; and as the separation of the particles in any fibre is proportional to the straining power, it follows that, within certain limits, the cohesive power between two particles of an elastic body is proportional to the distances to which one of them is removed by the straining force from the place where it was before at rest. The same law is considered to hold good when the particles of an elastic body are made to approach each other by the action of a compressing force like that of a weight on the top of a vertical pillar.

The power by which the particles in any body resist the action of a force tending to separate those particles in the direction of the length of the body may be considered as constituting the direct or absolute strength; and it is evident that, if the body were of a homogeneous texture, that strength would be proportional to the number of particles in a tranverse section; that is, to the area of such section, while the strain is proportional to the weight applied. Therefore, if F designate the cohesive power in a unit of such area, as a square inch, a square foot, &c.; also, if A represent the area and W the weight applied, including that of the body itself, we should have $FA = W$ when the strength and strain are in equilibrio. This formula for the absolute strength may be considered as nearly correct with respect to most of the bodies in nature; and hence (F being determined by experiment) the strength by which a rod of any material resists this kind of strain may be found when the dimensions of the rod are given.

For complete details concerning the experimental values of F, the reader must be referred to the extensive tables which have been published by Barlow ('Essay on the Strength of Timber'), Rennie ('Phil. Trans.,' 1818), Tredgold ('Principles of Carpentry'), Hodgkinson ('Experimental Researches into the Strength of Cast Iron,' &c.), and Morin ('Leçons de Mécanique Pratiqué,' vol. iv.), our limits permitting us to introduce only the few determinations which follow.

The area of a transverse section of each rod is one square inch, and the values of F are expressed by the breaking weights in pounds avoirdupois.

English oak	F = 8,000 to 12,000
Fir	11,000 to 13,488
Beech	11,500
Mahogany	8,000
Teak	15,000
Cast-steel	134,256
Iron-wire	93,964
Swedish bar-iron	72,064
Best English malleable iron . .	60,000
Cast-iron	18,656 to 19,488
Wrought-copper	33,792
Platinum wire	52,987
Silver do.	38,257
Gold do.	30,888
Zinc do.	22,551
Tin do.	7,129
Lead do.	3,146

Rope (1 inch circumference) bore .	1,000 lbs.,	F = 12,566
Whale-lines spun by hand (2 in. circumference)	2,240 ,,	7,087
Do. by machinery (1¾ in. circumf.)	3,520 ,,	12,582
Rope (3 in. circumf.) . . .	5,628 ,,	7,858
Do. (4 in. circumf.) . . .	9,988 ,,	7,845
Cable (14½ in. circumf.) . . .	89,600 ,,	5,355
Do. (23 in. circumf.) . . .	355,860 ,,	6,066

Notwithstanding the irregularities in the column containing the values of F for ropes, it may be concluded that large ropes of a given diameter have less strength on each square inch of their transverse section than those of less diameter; and this is owing, no doubt, to their threads being less twisted together. It may be observed, also, that those woods whose fibres are nearly straight bear much greater weights suspended from them than those whose fibres have considerable curvature.

According to the experiments of Mr. Barlow, it appears that a bar of malleable iron is extended one ten-thousandth part of its length by a direct strain equal to one ton for each square inch in the area of the transverse section: when stretched with ten tons per inch its elasticity was injured, or the bar did not return to its original state.

If the fibres in any material body were exactly rectilinear, so that, a rod being placed on one end in a vertical position, no one of the particles were opposite to the intervals between any two in a transverse section below it, it might be conceived that no force compressing the rod in the direction of its length would produce any other effect than that of diminishing its length. But as we find that all bodies when so compressed may be bent, and finally broken, such a disposition of the particles is destitute of probability. In fact, when a pillar is compressed by a great weight above it, either the fibres, already curved, have their curvature increased, so that the whole pillar bends; or the particles in some of the transverse sections are forced outwards by lateral pressures arising from the particles above and below their intervals being thrust between them, and then the pillar swells on its whole periphery. The consequence in either case is, that the cohesion of the longitudinal fibres is impaired or destroyed, and the pillar is at length broken or crushed.

The strength of a pillar when so compressed must evidently depend upon the number of particles in a transverse section—that is, upon the area of such section; but since, besides the displacement of those particles from the longitudinal pressure, their lateral cohesion must be overcome before they can be thrust outwards, it is evident that the strength is not proportional to the area, simply, but to some function of that area. No law on which any dependence can be placed has yet been discovered for the strength of a pillar in such circumstances. Euler, from analytical considerations, concluded that it varies as the square of the area; but late engineers have supposed that the square root of the third power of the area more correctly represents the law of the strength.

If a bar or pillar, resting on one end in a vertical position, and considered as a perfectly elastic body, be compressed by a weight acting vertically above it, the purely mathematical theory gives the following equation for the value of the compressing weight when the pillar begins to bend:—

$\mathrm{W}=\frac{\pi^2 ad^2}{12l^2}\delta$ (Poisson, 'Mécanique,' tom. i., No. 313); where W = the compressing weight; l = the length of the pillar; a = the area of the transverse section; d = the thickness perpendicularly to the bending surface; δ = the element of deflection; and $\pi = 3{\cdot}1416$. It follows that, when in two bars of like material a and d are respectively equal, the weights which those bars will sustain without bending are inversely proportional to the squares of the lengths.

It is also found, if w be a weight applied as above, and producing a flexure p, measured at the middle of the bar perpendicularly to its length, that $\delta=\frac{4wl^3}{ad^2p}$: this being substituted in the expression for W, the latter becomes $\mathrm{W}=\frac{\pi wl}{8p}$. (*Ibid.*, No 314.)

From Mr. Hodgkinson's experiments on the resistance of columns it appears that the shape of their bearing-ends has an important influence upon their power of supporting an insistent weight; for columns with flat and firmly bedded ends carried about three times the weight which broke other columns with rounded ends. It is customary at the present day to consider that the resistance of wrought iron to an effort of compression may be considered to be, at the minimum, 56,760 lbs. on the square inch (it is called by some engineers 67,200 lbs.); and according to Mr. Hodgkinson, if the resistance of cast iron be taken as unity, that of cast steel will be 2·518; that of wrought iron 1·745; whilst that of the best Dantzic oak will be 0·1088; and that of red deal 0·0785. In the cases of cast iron or of other columns the resistance is, however, affected by the ratios of the diameters to the length; and if the value of the resistance be taken at 56,760, and the safety load be taken at ⅕ of the crushing weight, the following table, translated from Claudel's 'Formules à l' usage des Ingénieurs,' may be considered to represent the loads it is advisable to bring upon solid wrought iron columns.

Ratio $r=\frac{l}{d}$	> 5	10	20	30	40	50	60	70	80
Load in lbs. per in.	11,352	7095	6484	5676	4824	4044	3391	2838	2384

This table is taken in preference to the one given in the same work for the strength of cast iron pillars; because the latter table is based upon a coefficient of resistance which seems to be rather too high, and it would therefore be preferable to affect the results of the table given by the ratios of the various materials above quoted. The various essays by Messrs. Chevaudier and Wertheim, 'Sur les Propriétés Mécaniques des bois' should be consulted by all engineers and architects who may be called upon to use those materials under heavy loads. It must also be observed that the shape of the column or body operated upon will materially affect its resistance to compression, for according to Navier and Duleau, with the majority of woods the resistance is in the ratio of $\frac{ab^3}{b^3}$, when the section is triangular; it is $\frac{b^4}{b^2}$ when the section is square, and $\frac{d^4}{b^2}$ when the section is circular.

The most important inquiry concerning the strength of materials is that which relates to a beam or bar supported at its extremities on two props, and strained transversely by a weight acting perpendicularly to its length at a given point between the props.

In order to simplify the investigation, it is usual to imagine that the beam, its breadth and depth being supposed uniform, is made to rest on one prop at the place where the weight may have been applied in the former case, suppose in the middle of its length, and that from the points where the two props were situated weights are suspended equal to the reactions of those props in consequence of the first weight; that is, to half the whole weight in the middle. Then, supposing the deflection of the beam to be very small, so that, in the former case, the beam did not slide on its point of support, the effect of the two weights to break the beam on its single prop will be the same as that of the one weight applied as at first supposed. Again, if a beam of equal dimensions with respect to breadth and depth were fixed at one end horizontally in a wall, the part projecting from the face of the wall being equal in length to half that of the former beam; and if a weight were applied at the opposite end equal to each of the two weights applied to the beam on one prop, the effect of this weight to break the beam at the face of the wall will be equal to that of the two weights to break the beam on the one prop, or of the double weight to break the same beam on two props. The investigation for the case at first supposed is therefore reduced to that of finding the strength of a beam attached at one end to a wall, and strained by a weight at the opposite extremity.

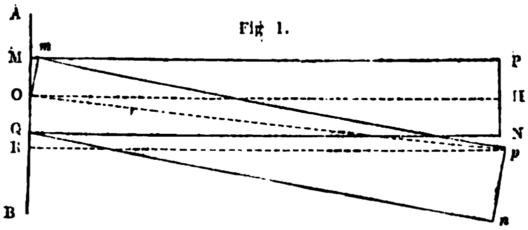


Fig 1.

Let A B (*fig.* 1) be the face of a wall, and let M N represent a vertical section of the beam in the direction of its length. Let it be supposed that the beam consists of an infinite number of fibres parallel to M P; then, if these fibres were supposed to be rigid and incompressible, the effect of a weight at P would be to bring the beam to an inclined position, as $m\,n$, producing a fracture on the line M Q by drawing the particles on that line away from those which were at first nearly in contact with them. But from experiment it is found that, when a beam is so strained, while the upper fibres are in a state of tension, the lower ones are in a state of compression; and consequently that there is a certain point O in the depth of the beam at which neither of these effects takes place. A line passing through this point perpendicularly to the plane M N is therefore called the neutral axis of the beam; and the termination of the fracture may be supposed to be at O instead of Q; the fibres below the former point having no effect in resisting the tendency of those above to be broken, yet constituting part of the strength of the beam by the power with which they resist compression, and thus oppose the tendency of the beam to turn about the neutral axis. The position of this neutral axis is uncertain; but Mr. Barlow, from experiment, has found that in rectangular beams of wood (the faces being in vertical and horizontal positions) its distance from the upper surface at M bears to the whole depth M Q the ratio of 1 to $1+\sqrt{3}$, or nearly that of 4 to 11. Therefore, d representing the depth M Q, let O M be represented by $\frac{4}{11}d$.

Now adopting the hypothesis of Leibnitz, which is founded on the elasticity of the fibres, that the force of cohesion in any one fibre is proportional to the tension to which it is subject, or to the distance of that fibre from the axis about which the beam turns in consequence of the strain; that is, from the neutral axis just mentioned: if x be the distance of any fibre above O from the latter place, and f represent the force of cohesion in the fibre at M P, we shall have $\frac{4}{11}d : f :: x : f\frac{11}{4d}x$: and the last term will express the force of cohesion between two particles at a distance above O equal to x. Consequently, dx expressing the indefinitely small depth of a fibre, we have $f\frac{11}{4d}x\,dx$ for the cohesive power of a fibre at the same place. But this power acting at a distance from O equal to x, we have $f\frac{11}{4d}x^2\,dx$ for the momentum of that force; and its integral will express the strength of all the fibres in the vertical section represented by M N. The transverse section of the beam being supposed to be rectangular, the breadth will be constant; let it be represented by b: then the integral of $f\frac{11b}{4d}x^2\,dx$ (between $x=0$, $x=\frac{4}{11}d$), that is $\frac{16b}{363d}f\,d^3$, or nearly $\frac{1}{23}bd^2f$, will express the strength by which all the fibres above the axis of O resist the strain.

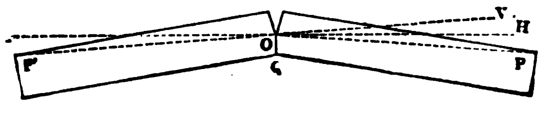
A corresponding expression for the strength arising from the resistance of the fibres below the neutral axis to the force of compression would be the integral of $f'\frac{11b}{7d}x^2\,dx$ (between $x=0$, $x=\frac{7}{11}d$), that is, nearly $\frac{2}{15}bd^2f'$ (f' being the force by which a fibre at Q N would resist compression), and the sum of the two integrals will be the whole strength of the beam to resist a transverse strain. Now the ratio of f to f' is different in different materials; and if we take $f' = \frac{1}{2} f$ (which is the case in some kinds of wood), the said sum will be $= \frac{1}{9} f b d^2$ nearly.

But when the beam is strained by a weight W applied at P, so that it takes the inclined position $m\,n$, if we join O and p, and let fall the perpendicular p R on A B, we shall have W . p R, or (if l be the length of the beam) W . l cos O p R, for the momentum of the weight. Then W . l cos O p R $= \frac{1}{9} f b d^2$ becomes the equation of equilibrium, W representing the weight which will just break the beam; and when $\angle$ O p R, or the deflection, is small, its cosine may be considered as equal to unity. It follows that the strength by which beams of the like material resist this kind of strain will vary as $\frac{bd^2}{l}$.

If a perfectly elastic beam or bar were attached horizontally at one end to a wall, and were strained by a weight W at the other end, the mathematical theory would give for the deflection of the opposite end of the beam (that is, the distance to which this end would be drawn in a vertical direction from the original position of the beam) $\Delta = \frac{W\,.\,l}{ad^2\delta}$ (Poisson, 'Mécanique,' tom. i., No. 310), where Δ = that deflection; l = the length of the beam; a = the area of the transverse section; d = the depth; and δ = the element of deflection. Therefore, if Δ be found from experiment on a beam or bar in which W, l, a, d, are given, we may from this equation obtain δ; and subsequently the value of Δ may be found for any beam, the materials being of the same kind. Again, the straining power by which a beam fixed at one end to a wall is dilated in the direction of its length is expressed by $a\,\delta\,D$ (*Ib.*, No. 308), where D is the element of dilatation. Now, if w be the weight which would produce the deflection δ and dilatation D, we should have $w = a\,\delta\,D$; whence $\frac{D}{w} = \frac{1}{a\,\delta}$; and the first member of this equation being substituted for its equivalent in the above expression for Δ, the latter becomes $\Delta = \frac{D\,.\,W\,.\,l^3}{w\,d^2}$; or since the elongation of the whole beam is proportional to the length, and may be represented by D . l, if we put E for this elongation when $w = W$, we shall have $\Delta = E\frac{l^2}{d^2}$. Whence the elongation of an elastic rod by a weight or power acting in the direction of its length is to the deflection of the same rod by a weight or power acting perpendicularly to its length, as the square of the depth or thickness is to the square of the length.

The relations between the strength and strain when a beam or bar, as M N in the preceding figure, is fixed at one end in a wall, and when a beam P′ M P in the annexed diagram (*fig.* 2), of equal dimensions with respect to breadth and depth, but twice as long, is supported on a prop at its middle point (the weight at each extremity of the latter being equal to that at the extremity of the former), are the same. Also the angle V O P of deflection (O V being in the direction of P′ O produced), when a beam is supported on a prop at Q, is equal to $\angle$ O p R, or $\angle$ H O p, in the preceding figure (O H being drawn perpendicular to the wall, or parallel to the horizon, and the beam M N being equal in every respect to one of the half-beams on the prop). For the angles M O m are equal in both cases; since the weight at P′ produces only the same effect as the reaction of the wall: and hence it follows that the angle H O P of deflection, with respect to the horizontal line H′ H, will be equal to only half the angle H O p. The same relation subsists between the deflections when the beam P′ M P is supported on the props at the extremities.

Fig. 2.



It will follow, from what was at first stated, that a beam attached at one end to a wall in a horizontal position will bear suspended from the other extremity only half the weight which the same beam will bear on its middle point when made to rest loosely on the two props. If the ends of the beam were prevented from rising on the props, the strength would, on account of the additional weight necessary to produce deflection or fracture at each end, be increased in the ratio of 3 to 2 nearly.

The following table contains a few of the results obtained from experiments made by Messrs. Banks, Barlow, and Tredgold, on wood and iron, when supported loosely on props and subject to a transverse strain at the middle point. The first column contains the length of the beam or bar in feet; the second, the areas of the transverse sections in square inches; the third, the breaking weights in pounds; and the last, the deflections at the middle points in inches.

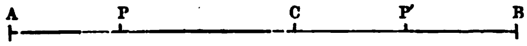
	Length.	Area.	Weight.	Deflection.
Young oak (English) .	2	1	482	1·87
Ship timber . . .	2½	1	264	1·5
Oak (English) . .	7	4	637	8·1
New England fir . .	7	4	420	4·66
Riga fir	2½	1	212	1·3
Teak	7	4	820	4·
Cast-iron bars . .	3	1	756	
Ditto	3	1	869	

Since the strengths of beams attached at one end or supported on props, the other dimensions being the same, vary as the squares of the vertical depths, it follows that the most advantageous position, when the areas of the transverse sections are equal, is that in which the broadest surface is in a vertical position. In this manner girders and joists in edifices are invariably placed.

When a beam or bar is attached at one end to a wall, or when it turns upon its middle point like the great lever of a steam-engine, if it be required that the beam should be equally strong in its whole length, it should be made to taper towards its extremities. When the depth of the beam is constant, the breadth at any point should be proportional to its distance from the extremity. When the breadth is to be constant, the vertical face of the beam should have the form of the common parabola; and when both breadth and depth vary, a longitudinal section of the beam should have the figure of that which is called a cubical parabola.

If a weight be applied at any point in the length of a beam which is supported on two props, the strain produced by it will be the greatest when it is placed in the middle; and the strain varies as the product of the distance of the weight from the points of support. For let A B (*fig.* 3) represent a beam supported at A and B, and let C be any point in it. Imagine a weight W to be applied at any point P; then, by the nature of the lever, A B : P B : : W : the pressure exerted by W on the point A, namely $\frac{W.\,PB}{AB}$; and this term expresses the re-action of the prop at A in consequence of the weight at P. Then also $\frac{W.\,PB}{AB}$ A C is equal to the strain at C produced by this re-action. Again, imagine a weight W′ to be applied at P′; then we shall have, as before, A B : P′ A : : W′ : $\frac{W'.\,P'A}{AB}$, and this last term expresses the reaction of the prop at B in consequence of the weight at P′: also $\frac{W'.\,P'A}{AB}$ B C is equal to the strain at C produced by this reaction. The sum of these strains is equal to the whole strain at C produced by the two weights. But when P and P′ coincide with C, we have P′ A = A C, P B = B C; and the sum of the two strains is $\frac{W.\,BC.\,AC}{AB} + \frac{W'.\,AC.\,BC}{AB}$; or, putting W″ for W + W′, we have the strain at C, in consequence of the weight W″ placed there, equal to W″. $\frac{AC.\,BC}{AB}$; and if W″ be a constant weight applied at any point in A B, the strain will vary as A C, B C. This rectangle, and consequently the strain, is a maximum when C is in the middle of the line.

Fig. 3.



If a weight be diffused over a beam which is fixed at one end to a wall, it may be considered as acting at its centre of gravity, which, if the diffusion be uniform, will be in the middle of the length of the beam. The momentum of the strain will consequently be equal to half of that which would result from an equal weight attached to the opposite end.

When a body is compressed in a direction perpendicular to the length of the fibres, the points of support being very near and on opposite sides of the place at which the force is applied, the strain to which the body is then subject has been called by Dr. Young the force of detrusion. This species of strain sometimes occurs in the construction of machinery; but few experiments have yet been made to determine the strength by which materials resist it. From these however it appears that the strength is proportional to the area of the transverse section, and that it varies from four-thirds to twice the strength by which the same material would resist a strain in the direction of its length.

Such machines as capstans and windlasses, and axles which revolve with their wheels, are, when in action, subject to be twisted, so that their fibres tend to become curved in oblique directions; and the strain thus produced is called that of torsion. The most natural way of investigating the strength of materials to resist this kind of strain is probably that which was adopted by Dr. Robison: this mechanician imagined the cylindrical body to be composed of an infinite number of concentric hollow cylinders inserted in each other; and, supposing the whole to be cut by a plane perpendicular to the axis, he conceived that two particles in the circumference of any one of the concentric circles would resist the effort to separate them, by a force proportional to their distance from the common axis. Hence, if the radius of the whole cylinder be r, and that of any one of the internal cylinders be x; also, if F' represent the force of cohesion between any two particles in the outer circumference, we have $r : F' :: x : \frac{F'}{r} x$. The last term expresses the like force in the circumference of the cylinder, whose radius is x, and the momentum of cohesion is $\frac{F'}{r} x^2$. But as all the particles in that circumference exert the same power, and the number of particles is proportional to x, it follows that $\frac{F'}{r} x^3$ will represent the sum of all the forces in the latter circumference, and $\frac{F'}{r} x^3\, dx$ will represent the sum in a hollow cylinder whose thickness, in the direction of the radius, is infinitely small and equal to dx. Then, by the rules of integration, we have for the strength of the whole cylinder the expression $\frac{F'}{4r} x^4$, which, between $x = 0$ and $x = r$, becomes $\frac{F'}{4} r^3$; and hence the whole strength of any cylinder varies as the cube of the radius.

But the area of any section of a cylinder whose radius is r being $= r^2 \pi$ (π being the half circumference of a circle when the radius $= 1$) it is evident that $F' r^2 \pi$ will represent the lateral cohesion by which all the particles resist being separated by the force of detrusion. Therefore the ratio between the force of detrusion and that of torsion will be as $r^2 \pi$ to $\frac{r^3}{4}$; or as 4π to r.

And since the strength under the latter strain depends on the radius, it is evident that a hollow cylinder must be stronger than a solid one; the areas of the material in the transverse sections being equal to each other.

The preceding reasoning is entirely founded on the supposition that the sections of the various solids considered had but a small importance upon their resistance to the various forces considered; but this is far from being the case in practice, and especially in the case of cast and wrought iron, the resistances of the upper and of the lower fibres of a rectangular beam differ to such an extent as to have rendered it necessary to carry out a long series of investigations into the real forms of solids of those particular materials presenting the greatest resistance. Mr. Hodgkinson, after Tredgold and Barlow in our own country, and Messrs. Morin and Love, after Navier, Coriolis, and Vicat, in France, have studied this complicated question; and the results of their inquiries, so far as the practical arts of construction are concerned, have been already alluded to under GIRDER, in which article also will be found enumerated the principal authors upon the subject it may be desirable for the student to consult. Very useful tables of the resistances of materials to efforts of compression, and of extension, may be found in Carr's 'Synopsis of Practical Philosophy,' 1843; Beardmore's 'Hydraulic, &c. Tables,' 1852; Moseley's 'Engineering and Architecture,' 1843; Willis's edition of Barlow, on 'Materials and Construction,' 1851; and Claudel's 'Formules à l'usage des Ingénieurs,' 1854.

MATHEMATICS (*μάθησις*, or *μάθημα*), a name given in the first instance to a branch of knowledge, not as descriptive of its subject-matter, but of the methods and consequences of learning it. The word *μάθησις*, and the Latin *disciplina* by which it has been rendered, have been the origin of the vernacular terms *mathematics* and *discipline*, the meanings of which have long since separated. The properties of space and number, the subject-matters of the *μάθησις*, have usurped the name; so that anything which relates to them, however learnt, is called mathematics: the Latin word, on the contrary, still retains the signification of a corrective process; and, in speaking of any branch of knowledge, is applied when power of mind is derived from the methods of learning it, as well as knowledge from the results.

The original use of the word mathematics cannot be gathered, so far as we can find, from any express contemporary authority; a few passages in which the term is used without explanation, as one of notoriety, being all that can be cited, and mostly from Plato. Later writers, as for instance Anatolius (cited by Heilbronner), A.D. 270, give the derivation above alluded to. But before the time of Anatolius the meaning of the word had been extended: thus the book of Sextus Empiricus "against the mathematicians" is, as Vossius remarks, directed as much against grammarians and musicians as against arithmeticians and geometers. And John Tzetzes, in the 12th century, includes under the *μαθηματα* nearly what the universities afterwards called by the name of arts; calling grammar, rhetoric, and philosophy, the disciplines (*μαθήματα*), and arithmetic, music, geometry, and astronomy, arts (*τέχναι*) included under philosophy.

The distinction between the old and new meaning of mathematics is most requisite to be kept in mind, because arguments are frequently urged for and against mathematics, in which the discipline is confounded with the communication of facts and processes about space and number; and because it is our intention in the present article, confining ourselves to the most important view of the science, as well as to the etymological meaning of its name, to offer a few remarks on the *discipline* called mathematics.

In the time of Plato, which was probably that of the application of words which imply "*the* discipline" to that one exercise of mind which consists in making deductions by pure reasoning from the self-evident properties of space and number, it is probable that such restriction of the word was easily justifiable. At present we have, besides mathematics, also physics, the study of antiquity, grammar, &c., which have all been made disciplines, but not one of which was then entitled to that appellation. Nevertheless it has happened that writers, misled partly by the name of mathematics and partly by the pre-eminence of mathematical reasoning in strictness and connection, have spoken as if it were the *only* cultivator of the pure reasoning power.

Much discussion has arisen upon the question whether those primary propositions which, from our clear apprehension and willing admission of them, are called self-evident, are notions inherent in the mind, or deductions of early experience. Except to mention this controversy, we have here nothing to do with it. The certainty of these propositions is all that we want, and this is conceded by both sides. The consideration however of the fundamental supports of mathematical reasoning is useful and interesting, and, as a safeguard, even necessary. It is not long since a school of metaphysicians existed who imagined that because all mathematical definitions are precise, therefore the exact sciences are founded upon definition. It was not to them a necessary result of the constitution of our faculties that the three angles of every triangle make up the same amount, but a consequence of definition, which might have been something else, upon different suppositions. We can hardly undertake to explain what we do not understand: if the opinion we have quoted have not the meaning we have given to it, there is in it some confusion of terms. We recommend every beginner in the subject to seek no knowledge about the character of fundamental propositions until he shall have become well acquainted with their consequences. He must take care to admit nothing which is not, or cannot be made, most evidently true; and he will find that all axioms, as they are called, have the highest sort of certainty, namely, that they cannot be imagined otherwise.

Whatever may be the psychological hypothesis to which it is referred, it is certain that there is a real distinction between a mathematical fact and one of any other kind. If we say that an unsupported bit of lead will fall to the ground, we state a fact of which we are as certain, in the sense of reliance, as we are of the other proposition that two straight lines cannot inclose a space. But in the former proposition an exception, or even a permanent alteration of the law, is conceivable by the imagination: in the latter the mind would feel sensible of absurdity if it attempted to construct the idea of an inclosure bounded by only two straight lines. No distinctive phrases can be too strong to express the essential difference of these two assertions; but it is a misfortune that all terms which create a sufficient distinction are linked to one or another theory of the human mind. If the mathematical student can receive these terms as indicative of the difference of species, without bending before an hypothesis about the conformation of his own reason, he will do well to adopt them; if, on the other hand, he feel compelled to agree with any one system of mental philosophy, he will neither impede nor advance his mathematical career.

The unavoidable certainty and definite character of mathematical conclusions have obtained for mathematics the name of *exact science*: but to this name it has not exclusive right. The laws under which we must think are the foundation of a science which has an equal claim with mathematics to any epithet which indicates either necessity or precision. Accordingly logic and mathematics are separate branches of exact science. There are but three things of which we cannot divest ourselves so long as we imagine ourselves to retain both existence and consciousness of existence: they are thought, space, and time. With everything else there is a possibility of dispensing; that is, the imagination can conceive everything got rid of, and out of existence, except its own consciousness in some kind of activity, and the space and time without which it cannot conceive existence. The necessary laws of thought are the subject matter of logic: the necessary properties of space and time are the subject matter of mathematics. *Number* is an offspring of the notion of time; enumeration is a succession in time; in no other way can *number* be distinguished from *multitude*. And geometry is, without need of illustration, the offspring of the notion of space.

There has long been something of schism between the cultivators of logic and those of mathematics. To establish this fact, and to speculate on the reasons of it, would require more space than we have to give. The effect has been unfortunate. The mathematician dispenses with the analysis of the laws of thought; the logicians avoid that field in which the laws of thought are applied to necessary matter. This state of things is perhaps mending, but until the improvement is very decided, neither mathematics nor logic will be what they ought to be, as component parts of liberal education.

The sciences of which we speak may be considered either as disciplines of the mind, or as instruments in the investigation of nature and the advancement of the arts. In the former point of view their object is to strengthen the power of logical deduction by frequent examples; to give a view of the difference between reasoning on probable premises and on certain ones, by the construction of a body of results which in no case involve any of the uncertainty arising from the previous introduction of that which may be false; to form the habit of applying the attention closely to difficulties which can only be conquered by thought, and over which the victory is certain if the right means be used; to establish confidence in abstract reasoning by the exhibition of processes whose results may be verified in many different ways; to help in enabling the student to acquire correct notions and habits of generalisation; to give caution in receiving that which at first sight appears good reasoning; to instil a correct estimate of the powers of the mind, by pointing out the enormous extent of the consequences which may be developed out of a few of its most fundamental notions, and its incapacity to imagine, much less to attain, the boundary of knowledge; to methodise the invention of the means of expressing thought, and to make apparent the advantages of system and analogy in the formation of language and symbols; to sharpen the power of investigation, and the faculty of suggesting new combinations of the resources of thought; to enable the historical student to look at men of different races, opinions, and habits, in those parts of their minds where it might be supposed *à priori* that all would most nearly agree; and to give the luxury of pursuing a study in which self-interest cannot lay down premises nor deduce conclusions.

As instruments in the investigation of nature and the advancement of the arts it is the object of the mathematical sciences to give correct habits of judgment and ready means of expression in matters involving degree and magnitude of all kinds; to teach the method of decomposing phenomena and ascending from the complicated forms of manifestation to the simple law which regulates them; to trace the necessary consequences of any law, assumed on suspicion, in order to compare those consequences with phenomena; to construct hypothetical representations of laws, or approximations to laws, which shall sufficiently represent phenomena; to convert processes of known accuracy, but complicated operation, into others which make up in simplicity for a certain amount of inaccuracy, and to devise means for judging of that amount of inaccuracy, and confining it within given limits; to ascertain the most probable result of observations or experiments which are discordant with each other from errors of measurement or unknown causes of disturbance; to point out the species of experiments which should be made to obtain a particular sort of information, or to decide between two laws which existing phenomena both indicate as of nearly equal credibility; to make all those investigations, which are necessary for the calculation of results to be used in practice, as in nautical astronomy, application of force and machinery, and conduct of money transactions; in a word, though that word by itself would have not presented a sufficiently precise idea, to find out truth in every matter in which nature is to be investigated, or her powers and those of the mind to be applied to the physical progress of the human race, or their advancement in the knowledge of the material creation.

The main branches of mathematical science were formerly stated to be arithmetic and geometry, springing out of the simple notions of number and space. This is too limited a description. Unquestionably the science of numbers, strictly and demonstratively treated, and that of geometry, or the deduction of the elementary properties of figure from definitions which are entirely exclusive of numerical considerations, must be considered as the elementary foundations, but not as the ultimate divisions, of mathematics. To them we must add the science of operation, or algebra in its widest sense,—the method of deducing from symbols which imply operations on magnitude, and which are to be used in a given manner, the consequences of the fundamental definitions. The leading idea of this science is operation or process, just as number is that of arithmetic, and space and figure of geometry: it is of a more abstract and refined character than the latter two, only because it does not immediately address itself to notions which are formed in the common routine of life. It is the most exact of the exact sciences, according to the idea of their exactness which is frequently entertained, being more nearly based upon definition than either arithmetic or geometry. It is true that the definitions must be such as to present results which admit of application to number, space, force, time, &c., or the science would be useless in mathematics, commonly so called; but it is not the less true that a system of methods of operation, based upon general definitions, and conducted by strict logic, may be made to apply either to arithmetic or geometry, according to the manner in which the generalities of the definition are afterwards made specific.

The common division of the mathematical sciences will not admit of the threefold separation just described, the science of operation being more or less mixed up with arithmetic, both in common algebra and in its application to geometry. We may describe this division as follows:—

1. *Pure Arithmetic*, subdivided into *particular* and *universal*:* the former, the common science of numbers (integral and fractional) and calculation; the latter, the science of numbers with general symbols, or the introduction to methods of operation, restricted to purely numerical processes. The science which treats of the peculiar relations of numbers, and subdivides them into classes possessing distinct properties, is called the *theory of numbers*, and is an extension which frequently requires a higher algebra.

2. *Pure Geometry*, which investigates the properties of figures in the manner of Euclid, that is, with restrictions which confine the student to the straight line and circle as the means of operation and the boundaries of figure. [GEOMETRY.] This science includes solid geometry, as far as figures bounded by planes, the properties of the sphere, cone, and cylinder, and of their plane sections; but it does not allow any conic section, except the straight line and circle, to be employed in the solution of problems.

3. *Algebra*, including the general calculus of operations (though this is not an elementary branch), and all methods which can be established without the aid of processes exclusively belonging to the differential calculus. The distinction between it and universal arithmetic is an extended use of operations, preceded by an extended definition of their meaning.

4. *Application of Algebra to Geometry*.—This includes *trigonometry*, and all those parts of geometry in which problems are numerically solved, and the method of Euclid is abandoned. Thus it includes the conic sections as commonly taught; and in its higher parts is an application of the differential calculus, as well as of algebra.

5. *Differential and Integral Calculus*.—Under this term we include the general theory of limits; that is, all digested methods of operation, in which the limits of ratios are used as algebraical quantities under specific symbols. This distinction is necessary, since the notion of a limit, and even propositions which belong to the differential calculus in everything but form, are contained in the elements of Euclid, and in the application of arithmetic to geometry. The *calculus of differences* and the *calculus of variations* are usually placed under this head: the former, in its elementary parts, might be referred to common algebra; the latter is an extension of the differential calculus.

The division of the mathematical sciences into *pure* and *mixed* is convenient in some respects, though liable to lead to mistake. By the former term is understood arithmetic, geometry, and all the preceding list; by the latter, their application to the sciences which have matter for their subject, to mechanics, optics, &c. But considering that in all these subjects a few simple principles are the groundwork of the whole deduction, they might be explained as intended to answer two distinct questions: first, what are the consequences of such and such assumptions upon the constitution of matter? secondly, are these consequences found to be true of matter as it exists, and are the assumptions therefore to be also regarded as true? In the reply to the first question, the science is wholly mathematical; to the second, wholly experimental in its processes, and inductive in its reasonings; and this is the *mixture* from which the joint answer to both questions derives its name, and not from any difference between its mathematics and those of the pure sciences. Again, a science does not take the name of mixed mathematics simply because it is possible to apply mathematical aid in the furtherance of its legitimate conclusions: such a use of terms would be trifling with distinctions, since it would bring political economy, chemistry, geology, and almost every part of natural knowledge, under the same head as mechanics and hydrostatics. The words in question should be reserved to denote those branches of inquiry in which few and simple axioms are mathematically shown to be sufficient for the deduction, if not of all phenomena, at least of all which are most prominent. Taking the leading ideas of the mixed sciences instead of their technical names, we may describe them as relating to motion, pressure, resistance, cohesion, light, heat, sound, electricity, and magnetism. As disciplines, it is their main object to teach the true method of inquiry into the laws, and, so far as can be known, the causes, of material phenomena; as instruments, it is not necessary to say one word about them. Two only have not been mentioned: the first, astronomy, which belongs to more than one of the preceding; the second, the theory of probabilities, of which, though placed among the mixed sciences, it may be affirmed that it ought to be called an *application* of mathematics to *logic*.

The most important question connected with the mathematical sciences is the manner in which they should be taught as disciplines of the mind. This concerns all who consider any branch of knowledge in that light; and, as education spreads, this view of the subject will become of more and more consequence. Vitally essential as these sciences are to the advancement of the arts of life, we feel, in regard to this branch of their utility, in the situation of those who know that they must and will be attended to, because their cultivation is necessary to the supply of wants which all can feel, and the promotion of interests which all can understand. It is not so with the first-mentioned object of their study, but rather the reverse; for the wants of life being as easily supplied by the results of an illogical as of a logical system (provided only that vicious reasoning be not allowed to produce absolute falsehood), the facilities which laxity of reasoning affords in the mere attainment of results will always recommend it to those whose main object it is to apply the fruits of calculation to the uses of life. Such has been, and, we are afraid, will continue to be, the tendency of the great advance which the last century made in application.

All we should positively contend for is the necessity of making the entrance to the study as strict and rigorous as reason can make it, to all who are to receive liberal education. In the higher branches of mathematics many opinions prevail, and it would be impossible to make a formal standard of rigour. Add to this, that, with a certain degree of experience in the estimation of reasoning, it may be comparatively immaterial which of several different methods is adopted; either may be rigorous if properly understood, and if the habit of reducing looseness of phraseology, or dangerous abbreviation of logic, to strict definition and formal deduction, shall first have been well formed. To assist in gaining this end, we should propose—

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* We have supplied the word particular, as opposed to universal; algebra was sometimes called universal arithmetic, but the phrase never became general, owing to its being obvious to those who studied algebra, that arithmetic, however general its symbols may be, is only a part of algebra.

First, that no student should be allowed to enter upon the use of language in mathematical reasoning until he has acquired more acquaintance with the nature of assertion, denial, and deduction, than can be obtained from previous education as now given: this to be done by the study of the first elements of logic.

Secondly, that no consideration of facility or practical convenience should prevent the first study of arithmetic and geometry from being strictly demonstrative, and formally rigorous: rigour being defined to consist in explicit statement of every assumption, and logical treatment of every inference.

On the first of the preceding recommendations we shall only observe, that in order to distinguish between accurate and inaccurate inference, an acquaintance with the exact extent of meaning of the several modes of communication is absolutely necessary. This cannot be learnt from the ordinary use of language, which abounds in implications to be suggested by the circumstances of the speaker, the context of the words, or the tone in which they are delivered. Before the phrases of demonstration can be made to convey a meaning limited in both directions, the strict use of language must be made a study; if this be neglected, the words of any book may pass between the teacher and the learner, but no precaution has been taken to secure their conveying the proper meaning, neither too much nor too little.

On the second recommendation, we must first explain that we hold many points of controversy very cheap, so far as they concern the discipline given by the most elementary branches of mathematics. It matters nothing, in our view of the case, whether an axiom be really incapable of proof, or whether the substitution of another would or would not place the science on a more simple basis. The habit to be formed is that of tracing necessary consequences from given premises by elementary logical steps: the premises to be true or false, the consequences to be true if the premises be true, and dubious (not necessarily false) if the premises be false. The only error which, at the stage in question, it is intended to avoid, is the deduction, as a necessary consequence, of that which is not so. The mind of the learner, however, is allowed to dwell too much at the outset on the absolute truth or falsehood of the conclusions, to the neglect of their connection with the premises: hence it arises that when a process occurs in which it is essential to examine that connection for its own sake, it is the universal complaint that beginners find difficulty and obscurity. From what other cause arises the dislike of the indirect demonstration?

Unfortunately for the mental progress of the student, he is often allowed to use premises of an easy form, in cases where complete preparation for the subject would require more extended first principles and greater prolixity of deduction. To this, as before observed, no objection can be taken in itself, provided that no consequences be admitted except the legitimate ones. But something more is admitted: the pupil is presented, in consideration of his attention to one set of premises, with the consequences of another, and is allowed to make believe that he has come fairly by the latter. Thus, by a theory which applies only to the ratio of number to number, he is permitted to draw general conclusions upon all ratios. When, in opposition, we advise that the first studies should be demonstrative and rigorous, we do not imply, for instance, that the more difficult system should in all cases be preferred to the less complete but more simple: we confine ourselves to insisting that whatever the premises may be, the conclusions should really follow; and that if the latter be necessarily of a limited character the limitation should be stated.

The work of Euclid is preferable, in our opinion, to any system which has been proposed to supply its place; simply because the dependence of conclusions upon premises is more distinct than in any other geometrical writing. The defects with which it abounds are trifles which can be remedied as they are met with; and though there are seldom three propositions together one or other of which will not call for some remark from the teacher, yet such is Euclid, that these very faults, properly noted, are of more value than the greater elegance and more artificial process of less formally rigorous writers. Of the part relating to Proportion we shall treat under that word.

The necessity of a demonstrative system of arithmetic was practically denied, in this country at least, by the use of a set of dogmatical rules: and this mode of teaching is still too prevalent. Such training would be less prejudicial if the notions of the student on reasoning were more settled, so that he could receive these rules with some fitting idea of their purpose, and of the extent to which they are to be considered as knowledge. As it was, he had no other view of arithmetic presented to him, and his conceptions of number were allowed to be first fettered, and afterwards led astray, by ideas derived sometimes from the reception of the conventional for the necessary, sometimes from modifications of truth which are convenient in practice though unsound in theory. Such an addition to his stock of mathematical power predisposed him to acquiesce in the shifts by which rigour is avoided in other parts of the science; and an arithmetic from which both sequence and accuracy of thought had been excluded was the asylum of geometry against truth, when the latter became (too difficult for an unenergetic, that is untrained, power of investigation.

We shall conclude this article with some references to works on the history of mathematics, a subject so connected with that of the other sciences, that it would be impossible to say anything on it in few words. The great work of Montucla, continued (from his papers partly) by Lalande, 'Histoire des Mathématiques,' 4 vols., Paris, 1799-1802, is the most accessible source of information for the reader who desires some detail. The bibliography of Murhard, 'Litteratur der Mathematischen Wissenschaften,' Leipzig, 1797, will be found a useful accompaniment in the verification of dates. The work of Kästner, 'Geschichte der Mathematik,' Göttingen, 1796, is more precise in its account of individual labours than that of Montucla, but does not embrace so large a field. The works of Bossut, namely, the preface to the mathematical part of the 'Encyclopédie Méthodique' and the 'Histoire des Mathématiques,' 2 vols. 8vo., Paris, 1810, are written in an interesting manner; and the latter (which was translated by Bonnycastle) brings some parts of the history later than its predecessors. Cossali's 'Origine dell' Algebra,' 2 vols. 4to., Parma, 1799, is an account of the early Italian algebra: its successor in the same subject, 'Histoire des Sciences Mathématiques en Italie,' Paris, 1838, by M. Libri (of which four volumes have appeared) has gained a character which places it among the first efforts of the kind. Much on the subjects of algebra, logarithms, and trigonometrical tables may be found in Dr. Hutton's Tracts (3 vols. 8vo., 1812), and in the preface of his Logarithms. The work of Montucla, 'Récherches sur la Quadrature du Cercle,' reprinted with additions in 1831, is complete on the subject of which it treats. There is a work on a kindred subject which we have never seen, Reimer, 'Historia Problematis de Cubi Duplicatione,' Göttingen, 1798. Delambre's 'Rapport Historique sur les Progrès des Mathématiques depuis 1789,' Paris, 1810, is the least specific of his historical works, but, points of nationality apart, is accurate. Professor Peacock's article on arithmetic in the 'Encyclopædia Metropolitana,' and his report on Analysis, in the second volume of the 'Transactions of the British Association,' are full of historical information of the most precise character. Some notices of early English mathematicians, enough to guide the reader to sources of information, are contained in the 'Companion to the Almanac' for 1837, and in the 'Magazine of popular Science,' Nos. 18, 20, and 22 (a work completed in 4 vols. 8vo). The eleventh volume of the 'Memoirs of the Academy of Brussels' contains the 'Aperçu Historique,' &c. of M. Chasles, a history of geometry and a complete account of its modern progress.

Among works of older date, which are often cited, we may notice Ward's 'Lives of the Gresham Professors,' London, 1760; Heilbronner's 'Historia Matheseos Universæ,' Leipzig, 1742, does not deserve that title, but contains an immense quantity of information on the ancient part; G. J. Vossius, 'De quatuor Artibus popularibus,' Amsterdam, 1650, contains a large number of dates and short biographical accounts; to Blancanus, 'De Mathematicarum Naturâ Dissertatio,' Bologna, 1615, is appended a chronological list of mathematicians up to the time of Galileo; the 'Scolæ Mathematicæ' of Peter Ramus, Frankfort, 1627, contains many historical notices. The number of writings which might be referred to as incidentally affording information is of course numerous.

MATHEMATICS, RECENT TERMINOLOGY IN. The terms intended to be explained in the present article relate to subjects distinct indeed, but intimately connected together, as well logically as historically. *Determinants* were devised as a means to the solution of a system of simple equations, but the principle of their construction is contained in the rule of signs which belongs to the theory of *arrangements* (or permutations): this theory has been studied, as well for its own sake, as in reference to the theory of equations, and in it originated the notion of a *group*, the most outlying term of those which are here explained. Moreover, in a system of simple equations, if the coefficients arranged in the natural square order are considered apart by themselves, this leads to the theory of *matrices*, a theory which indeed might have preceded that of determinants; the matrix is, so to speak, the matter of a determinant; the rule of signs giving the form. But when the rule of signs is applied to other matter, this leads to the functions called *permutants;* these include *commutants* and *intermutants*, and also *Pfaffians*, which however were not originally so arrived at. The theory of elimination (according to one of the two ways in which it may be treated) is essentially dependent upon systems of linear equations, and is thus also connected with determinants. And all, or nearly all, the before-mentioned theories have an application to the theory of rational and integral homogeneous functions, or, as they have been termed, *forms* or *quantics;* they are thus connected with the "Calculus of Forms," and with "Quantics;" the last-mentioned expression (used as a singular), has been defined to denote the entire subject of rational and integral functions, and of the equations and loci to which these give rise. The theory of rational and integral functions was first studied in a general manner in the question of *linear transformations*, and it was this question which led to the discovery of the functions, called originally *hyperdeterminants* but afterwards *invariants*, and of the more general functions called *covariants*: the theory of covariants is indeed the part which has been chiefly attended to of the Calculus of Forms, or of Quantics.

The following list of terms may be convenient:—

- Rule of signs.
- Group.
- Determinant.
  - Minor,
  - Symmetric, skew, skew symmetric.
- Commutant.
- Pfaffian.
- Permutant.
- Intermutant.
- Cumulant.
- Matrix.
- Resultant.
- Discriminant.
- Plexus.
- Rational and integral functions (notation and nomenclature of).
  - Quantic, quadric, cubic, &c., binary, ternary, &c., facient, tantipartite, lineolinear.
- Emanant.
- Linear transformations.
  - Modulus of transformation, unimodular.
- Hyperdeterminant.
- Invariant.
- Covariant.
  - Contravariant, peninvariant, seminvariant, quadriuvariant, quadricovariant, &c., catalecticant, canonisant.
- Canonical form.
- Bezoutic matrix, &c.
- Tactinvariant, reciprocant.
- Functional determinant, Jacobian, Hessian.
- Concomitant, cogredient, contragredient.
- Combinant.

Rule of Signs.—Any arrangement of a series of terms may be derived (and that in a variety of ways) from any other arrangement by successive interchanges of two terms; but in whatever way this is done, the number of interchanges will be constantly even, or else constantly odd; and the two arrangements are said to be of the same sign or of contrary signs accordingly. In particular, if any arrangement is selected as the primitive arrangement, and taken to be positive, then any other arrangement will be positive or negative according as it is derivable from the primitive arrangement by an even or an odd number of interchanges. The definition leads to the following theorem: any arrangement is positive or negative, according as the total number of times in which the several elements respectively precede (mediately or immediately) elements posterior to them in the primitive arrangement, is even or odd: it may be added, that the positive and negative arrangements are equal in number. Thus in the case of three terms, the primitive arrangement being 123; the positive arrangements are 123, 231, 312, the negative arrangements, 132, 213, 321: in the case of four terms, the primitive arrangement being 1234, the arrangements 1234, 2341, 3412, 4123 are respectively positive, negative, positive, negative; there are in all twelve positive and twelve negative arrangements.

Group.—The term was originally used as applied to substitutions only, but the more general use of the term is as follows: let θ be a symbol operating on any number of terms $x, y\ z$ . . and producing as the result of the operation the same number of new terms X, Y, Z, . . (where X, Y, Z . . . may be each of them functions of all or any of the set, x, y, z . . ; if X, Y, Z . . are merely the terms, x, y, z . . in a different order, then θ is a substitution, which explains in what sense that term has just been used). Imagine a set of operative symbols, 1, θ, ϕ, χ . . (1, as an operative symbol denotes, of course, a symbol which leaves the operand unaltered) such that the result of the operation of *any* two symbols θ, ϕ (the same or different, and if different, then in either order) is identical with that of the operation of *some* symbol χ of the set; as thus, $\theta\phi(x, y, z\,..) = \theta(\mathrm{X}, \mathrm{Y}, \mathrm{Z}, ..) = (\mathrm{X}', \mathrm{Y}', \mathrm{Z}', ..) = \chi(x, y, z\,..)$, say, $\theta\phi = \chi$; then the symbols 1, θ, ϕ, χ . . . form *a group*. It is to be remarked that 1 belongs to every group, and moreover, that if θ be any symbol of the group, then $\theta^2, \theta^3, \theta^4$, . . belong to the group: the most simple form of a group (and when the number of terms is prime, the only form) is $1, \theta, \theta^2 \ldots \theta^{n-1}$ $[\theta^n = 1]$. More generally, if there are n terms in the group, then every symbol θ of the group is an operation periodic of the order n (if not of an order a submultiple of n) and thus satisfies the symbolic equation $\theta^n = 1$. The symbols of the group are, so to speak, the symbolic n-th roots of unity, and as in the above-mentioned example, they may, whether n is prime or composite, form a system precisely analogous to that of the ordinary n-th roots of unity; but when n is composite, then upon two grounds this is not of necessity the case. 1°. The symbols of a group need not be convertible (thus $n=6$, there is a group, $1, \beta, \beta^2, a, a\beta, a\beta^2$ $[a^2=1, \beta^3=1, \beta a = a\beta^2$ and $\therefore \beta^2 a = a\beta$, this is in fact, the group of the substitutions of three things). 2°. There may be distinct n-th roots, thus $n = 4$, there is a group, $1, a, \beta, a\beta$ $[a^2=1, \beta^2=1, a\beta=\beta a]$, in which a, β are distinct square roots of (the symbolical) unity, and which is thus wholly different from the group, $1, a, a^2, a^3$ $[a^4=1]$.

The combination of a series of terms in the way of addition or subtraction, according to the rule of signs, gives rise to the class of functions called permutants, which include as a particular but the earliest discovered and most important case, the determinant.

Determinant.—Imagine a square arrangement of terms, for example—

$$\begin{vmatrix} a, & b, & c \\ a', & b', & c' \\ a'', & b'', & c'' \end{vmatrix}$$

and taking this as the primitive arrangement, permute in every possible way entire columns (or, what would give the same result, entire lines) and for each such arrangement form the product of the terms in the dexter diagonal (N.W to S.E) of the square, giving to such product the sign which belongs to the arrangement of the columns (or lines). The algebraical sum of these products is a determinant, and such determinant is, or may be represented as above, by inclosing the terms within two vertical lines. Thus the developed value of the determinant in question is

$$ab'c'' - ab''c' + a'b''c + a''bc' - a''b'c - a'b''c$$

The rule may be otherwise stated as follows: a determinant is the sum of a series of products each with its proper sign, such that in each product the factors are taken out of each line and out of each column, and if the factors are arranged according to the primitive arrangement of the columns in which they occur, then the sign is that corresponding to the resulting arrangement of the lines (or *vice versâ*); thus in the product — $ab''c'$, the factors a, b'', c' occur in the columns 1, 2, 3 (they are therefore arranged according to the primitive arrangement of the columns) and in the lines 1, 3, 2. Such arrangement of the lines considered as derived from the primitive arrangement 1 2 3 is negative, and the product has therefore the sign —. A generalisation of this construction will be mentioned under the term commutant.

The word *resultant* was formerly used as synonymous with determinant, but it is now employed and is here explained in a more extended signification. The new synonym *eliminant* seems unnecessary.

A few of the numerous properties of determinants may be stated.

A determinant is a linear function (without constant term) of the terms in each of its columns, and also of the terms in each of its lines, or, more briefly expressed, it is a linear function of each column, and also of each line. Moreover, without altering the value of the determinant, the lines may be made columns, and the columns lines, and all the properties of the function exist equally with respect to the lines and with respect to the columns. The absolute value of the determinant is not altered, but the sign is reversed, by an interchange of two columns, hence also if two columns become identical, the determinant vanishes. Moreover when the columns are permuted in any manner whatever, the absolute value is not altered, but the sign will be that corresponding to the arrangement of the columns. A determinant may be developed as a linear function of the terms in any line, thus—

$$\begin{vmatrix} a, & b \\ a', & b' \end{vmatrix} = a\,|\,b'\,| - a'\,|\,b\,|\,,$$

$$\begin{vmatrix} a, & b, & c \\ a', & b', & c' \\ a'', & b'', & c'' \end{vmatrix} = a \begin{vmatrix} b', & c' \\ b'', & c'' \end{vmatrix} + b \begin{vmatrix} c', & a' \\ c'', & a'' \end{vmatrix} + c \begin{vmatrix} a', & b' \\ a'', & b'' \end{vmatrix},$$

the signs being alternately positive and negative or else all positive, according as the number of columns is even or odd.

The square arrangement of terms out of which a determinant is formed, and generally any square or rectangular arrangement of terms, is called a matrix. Consider a determinant.

$$\begin{vmatrix} a, & b, & c, & d \\ a', & b', & c', & d' \\ a'', & b'', & c'', & d'' \\ a''', & b''', & c''', & d''' \end{vmatrix}$$

and partitioning the lines in any manner, form with them the matrices

$$\begin{vmatrix} a, & b, & c, & d \\ a', & b', & c', & d' \end{vmatrix}, \quad \begin{vmatrix} a'', & b'', & c'', & d'' \\ a''', & b''', & c''', & d''' \end{vmatrix},$$

and out of these matrices, with complementary columns thereof, a sum of products

$$\Sigma \pm \begin{vmatrix} a, & b \\ a', & b' \end{vmatrix} \begin{vmatrix} c'', & d'' \\ c''', & d''' \end{vmatrix},$$

(the sign ± being that corresponding to the product $a\,b'\,c''\,d'''$ of the terms in the dexter diagonals of the factor determinants, considered as a term of the original determinant), the sum of all the products so obtained is the original determinant.

It has been mentioned that the determinant is a linear function of each column; hence if the terms of any column are pa, pa' . . the determinant is equal to p times a determinant in which the corresponding column is a, a' . . . and similarly if the column is $a+b, a'+b'$, . . then the determinant is the sum of two other determinants in which the corresponding columns are a, a', . . . and b, b', . . . respectively.

This property, in combination with some of those already mentioned, leads very simply to the rule for the multiplication of determinants; for example, we have

$$\begin{vmatrix} \rho, & \sigma \\ \rho', & \sigma' \end{vmatrix} \begin{vmatrix} \alpha, & \beta \\ \alpha', & \beta' \end{vmatrix} = \begin{vmatrix} \rho\alpha + \sigma\beta, & \rho'\alpha + \sigma'\beta \\ \rho\alpha' + \sigma\beta', & \rho'\alpha' + \sigma'\beta' \end{vmatrix},$$

from which the law is obvious. The product might also be expressed, and although it appears less simple, there is an advantage in expressing it, in the form

$$\begin{vmatrix} \rho\alpha + \sigma\alpha', & \rho\beta + \sigma\beta' \\ \rho'\alpha + \sigma'\alpha', & \rho'\beta + \sigma'\beta' \end{vmatrix}.$$

If we omit simultaneously any line and any column of a determinant, and with the terms which are left form a determinant, the determinants so obtained are the *first minors* of the given determinant. A similar process, but omitting pairs, triads, &c. of lines and columns, gives the *second minors, third minors*, &c. of the given determinant. But the first minors are the most important, and are sometimes spoken of simply as the minors.

A determinant

$$\begin{vmatrix} a, & h, & g \cdot\cdot \\ h, & b, & f \\ g, & f, & c \\ \vdots & & \end{vmatrix} \quad \text{or} \quad \begin{vmatrix} 11, & 12 \cdot\cdot \\ 21, & 22 \\ \vdots & \end{vmatrix},$$

where the corresponding terms on opposite sides of the dexter diagonal are equal to each other (say $rs = sr$) is said to be *symmetrical*.

But if the terms are equal in magnitude only, but have opposite signs (say $rs = -sr$, this relation not extending to the terms *in* the diagonal, for which $s = r$) the determinant is said to be *skew*; and if the relation extends to the case $s = r$, or what is the same thing, if the terms *in* the diagonal vanish, the determinant is said to be *skew symmetrical*. Skew determinants have an intimate connection with the functions called Pfaffians.

COMMUTANT.—The second rule for the construction of a determinant might have been thus stated, viz. for the determinant

$$\begin{vmatrix} 11, & 12 \,.\,.\, 1n \\ 21, & 22 \\ \vdots & \\ n1 & \end{vmatrix}$$

write down the expression

$$\begin{matrix} 1\,1 \\ 2\,2 \\ \vdots \\ n\,n \end{matrix}$$

and permute in every possible way the numbers in the first column, prefixing in each case the sign of the arrangement. Then reading off

$$\pm \begin{matrix} r\,1 \\ s\,2 \\ \vdots \\ z\,n. \end{matrix}$$

as meaning

$$\pm\, y1 \,.\, s2 \ldots z\,n$$

the sum of all the terms so obtained is in fact the determinant in question. The same result would be obtained by permuting the numbers in the second column instead of those in the first column. And moreover, if the numbers in both columns are permuted, the sign being the sign $\pm \pm$ compounded of the signs corresponding to the separate arrangements, the only difference is, that the determinant will be multiplied by the numerical factor 1. 2. 3. . . n.

If instead of two we have three or more columns, the resulting function is a *commutant*. But a distinction is to be made according as the number of columns is even or odd. In the former case we may permute all but one of the columns, and it is indifferent which column is left unpermuted; and if all the columns are permuted, the effect is merely to introduce the numerical factor 1. 2. 3. . . . n. In the latter case, if all the columns are permuted, the result is zero, and it is therefore essential that one column should remain unpermuted; moreover, different results are obtained according to the column which is left unpermuted, and such column must therefore be distinguished; this is done by placing above it the mark †.

PFAFFIAN.—Suppose that the terms 12, 13, 21, &c., are such that $21 = -12$, and generally that $sr = -rs$, then the Pfaffians 1234, 123456, &c., are defined by means of the equations

$$1234 = 12.34 + 13.42 + 14.23,$$
$$123456 = 12.3456 + 13.4562 + 14.5623 + 15.6234 + 16.2345,$$
(where of course $3456 = 34.56 + 35.64 + 36.45$, and so for 4562, &c.)

and so on. The functions in question occur in the solution of an important problem (including that of partial differential equations of the first order and of any degree) known as Pfaff's problem, and were named accordingly.

It may be noticed that a skew symmetrical determinant of any odd order is equal to zero; but that a skew symmetrical determinant of any even order is the square of a Pfaffian, e.g. if $12 = -21$, &c., as above, then

$$\begin{vmatrix} 0, & 12, & 13, & 14 \\ 21, & 0, & 23, & 24 \\ 31, & 32, & 0, & 34 \\ 41, & 42, & 43, & 0 \end{vmatrix} = (12.34 + 13.42 + 14.23)^2.$$

PERMUTANT.—A very simple instance of a permutant is as follows, viz.: v_{123}, v_{213}, &c., being any quantities whatever, then the permutant $((v_{123}))$ denotes the sum

$$v_{123} + v_{231} + v_{312} - v_{132} - v_{213} - v_{321}$$

and in like manner for any number of permutable suffixes, or if instead of a single set of permutable suffixes we have two or more sets of such suffixes. It will be at once obvious how a permutant includes a determinant, commutant, or Pfaffian; thus, if v_{123} denotes $\alpha_1\beta_2\gamma_3$ and therefore $v_{213} = \alpha_2\beta_1\gamma_3$, &c., then we have a determinant, so if v_{1234} denotes $a_{12}.a_{34}$ where $a_{21} = -a_{12}$, &c., we have a Pfaffian.

INTERMUTANT is a special form of permutant which need not be here further explained.

CUMULANT.—The name has been given to the function which is the numerator or denominator of a continued fraction. Such function may be exhibited (and indeed naturally presents itself) in the form of a determinant, thus the cumulant $(a\,b\,c\,d)$ or numerator of the fractions $a + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}$ is

$$\begin{vmatrix} a, & 1, & \cdot, & \cdot \\ -1, & b, & 1, & \cdot \\ \cdot, & -1, & c, & 1 \\ \cdot, & \cdot & -1, & d \end{vmatrix},$$

and so for a greater number of terms. The developed expression is $abcd + ab + ad + bc + 1$, which is formed from the produced $abcd$ by successively omitting each product (cd, bc, ab), or set of products (cd, ab) of two consecutive letters; in like manner the cumulant $(a\,b\,c\,d\,e)$ is $abcde + abc + abe + ade + a + c + e$.

MATRIX.—The term might be used to denote any arrangement of terms, but in a restricted sense it denotes a square or rectangular arrangement of terms, and it is thus employed in the theory of determinants.

To show further how the notion of a matrix is made use of, it may be remarked that a system of linear equations

$$\xi = a\,x + b\,y + c\,z,$$
$$\eta = a'\,x + b'\,y + c'\,z,$$
$$\zeta = a''x + b''y + c''z$$

is in the notation of matrices represented by

$$(\xi, \eta, \zeta) = \begin{pmatrix} a, & b, & c \\ a', & b', & c' \\ a'', & b'', & c'' \end{pmatrix} (x, y, z)$$

The corresponding set of equations which give (x, y, z) in terms of (ξ, η, ζ) is represented by,

$$(x, y, z) = \left(\begin{pmatrix} a, & b, & c \\ a', & b', & c' \\ a'', & b'', & c'' \end{pmatrix} \right)^{-1} (\xi, \eta, \zeta)$$

and we have thus the definition of the *inverse* or *reciprocal* matrix: it follows from the theory of determinants that the terms of the reciprocal matrix are the first minor determinants formed out of the original matrix, each of them divided by the determinant formed out of the original matrix; but in writing down the expression some attention is required with respect to the arrangement and signs of the terms.

Similar considerations lead to the notion of *multiplying* or *compounding* together two or more matrices. As an instance of such composition, take

$$\begin{pmatrix} \rho, & \sigma \\ \rho', & \sigma' \end{pmatrix} \begin{pmatrix} \alpha, & \beta \\ \alpha', & \beta' \end{pmatrix} = \begin{pmatrix} \rho\alpha + \sigma\alpha', & \rho\beta + \sigma\beta' \\ \rho'\alpha + \sigma'\alpha', & \rho'\beta + \sigma'\beta' \end{pmatrix}$$

where it is to be observed that the lines of the first or *further* component matrix are compounded with the columns of the second or *nearer* component matrix to form the lines of the compound matrix. The words further, nearer, are used in reference to a set (x, y) which is, or may be considered to be, understood at the right of each side of the equation. A matrix may be compounded with itself once or oftener, giving rise to a positive power of such matrix; the notion of the negative powers is deducible from that of the inverse or reciprocal matrix, and the same process of generalisation as is employed for powers of a single quantity leads to the notion of the fractional powers of a matrix. As a definition of *addition*, matrices are added together by the addition of their corresponding terms, and as a particular case of the multiplication or composition of matrices we have the multiplication of a matrix by a single quantity, effected by multiplying by such quantity each term of the matrix; all these notions together lead to the notion of *functions* of a matrix.

As an instance of the employment of the notation of matrices for another purpose, take

$$\left(\begin{matrix} a, & b, & c \\ a', & b', & c' \\ a'', & b'', & c'' \end{matrix}\right)(x, y, z)(\xi, \eta, \zeta),$$

used to denote the lineo-linear function

$$\begin{aligned} &(a\,x+b\,\,y+c\,\,z)\xi \\ +&(a'x+b'\,y+c'\,z)\eta \\ +&(a''x+b''y+c''z)\zeta \end{aligned}$$

which includes

$$\left(\begin{matrix} a, & h, & g \\ h, & b, & f \\ g, & f, & c \end{matrix}\right)(x, y, z)^2,$$

used to denote the quadric function

$$a\,x^2+b\,y^2+c\,z^2+2\,f\,y\,z+2\,g\,z\,x+2\,h\,x\,y.$$

The last preceding notation is an instance of a *symmetrical* matrix: the terms *skew, skew symmetrical*, already explained with respect to determinants, apply also to matrices.

Resultant.—If there be a system of equations between the same number of unknown quantities (it is assumed that the several equations are of the form U=0, where U is a rational and integral homogeneous function), then the function of the coefficients which equated to zero expresses the result of the elimination of the unknown quantities from the several equations, or (what is the same thing) gives the condition for the existence of a set of values satisfying the equations simultaneously—is the *Resultant* of the equations, or of the functions which are thereby put equal to zero. In the case of two (non-homogeneous) equations involving a single unknown quantity, we may say more briefly that the resultant is the function which equated to zero gives the condition for the existence of a common root. In the particular case of a system of linear equations between as many unknown quantities, the resultant is the determinant formed with the coefficients of the equations.

Discriminant.—If in a system of equations the functions equated to zero are the derived functions of a single rational and integral homogeneous function with respect to each of the variables thereof, the resultant of the system is said to be the discriminant of the single function. The definition is easily made applicable to the case of a non-homogeneous function, the functions equated to zero are here the function itself and its derived functions with respect to each of the several variables. For a single function, it may be said that the discriminant is the function which equated to zero gives the condition for a pair of equal roots of the equation obtained by putting the function equal to zero.

To fix the precise value of the discriminant of a given function, it is assumed that the coefficient of some one selected term is +1. Thus, the discriminant of $a\,x^2+2\,b\,x\,y+c\,y^2$ is $a\,c-b^2$: that of $a\,x^3+3\,b\,x^2y+3\,c\,x\,y^2+d\,y^3$ is $a^2d^2-6\,a\,b\,c\,d+4\,a\,c^3+4\,b^3d-3\,b^2c^2$.

In quadratic forms (in the theory of numbers) the expression b^2-ac, which is the determinant $\begin{vmatrix} a, & b \\ b, & c \end{vmatrix}$ with the sign reversed, is called the determinant of the form $a\,x^2+2\,b\,x\,y+c\,y^2$. And in like manner for ternary quadratic forms, there is the same reversal of sign. It may be said as a convenient definition, that the determinant is the discriminant taken negatively.

Plexus.—It frequently happens, in problems of elimination and in other problems, that a given number of relations existing between a system of quantities can only be completely expressed by means of a greater number of equations. Thus, to take a very simple instance, if the unknown quantities x, y, are to be eliminated between the three equations $a\,x+b\,y=0$, $a'x+b'y=0$, $a''x+b''y=0$: this implies two relations between the coefficients a, b, a', b', a'', b''; but these relations cannot be completely expressed otherwise than by means of the three equations $a\,b'-a'b=0$, $a'b''-a''b'=0$, $a''b-a\,b''=0$; for taking any two of these equations, e.g. the first and second, these would be satisfied by $a'=0$, $b'=0$, which however do not satisfy the third equation and are not a solution. Such a system of equations, or generally the system of equations required for the complete expression of the relations existing between a set of quantities (and which are *in general* more numerous than the relations themselves) is said to be a *Plexus*.

Rational and Integral Functions (*Notation and Nomenclature of*).—A rational and integral homogeneous function, such as the function $ax^2+2bxy+cy^2$ is denoted by—

$$(*)(x, y)^2$$

where the coefficients are only indicated by the asterisk, but are not expressed. A non-homogeneous rational and integral function is considered as derived from a homogeneous function by putting one of the variables thereof equal to unity, and is represented accordingly: thus $ax^2+2bx+c$ is denoted by

$$(*)(x, 1)^2.$$

But it is often proper to express the coefficients, and in regard to this the following distinction is made, namely—

$$(a, b, c)(x, y)^2$$

denotes $a\,x^2+2\,b\,x\,y+c\,y^2$; and in like manner $(a, b, c, d)(x, y)^3$ denotes $a\,x^3+3\,b\,x^2y+3\,c\,x\,y^2+d\,y^3$, &c., the numerical coefficients being those of the successive powers of a binomial. But when such numerical coefficients are not to be inserted, this is denoted by an arrowhead, or other distinctive mark; thus $(a, b, c)\dagger(x, y)^2$ denotes $a\,x^2+b\,x\,y+c\,y^2$. A rational and integral function of any order is termed a *quantic*, and a function of the orders two, three, four, five, &c., is termed a *quadric, cubic, quartic, quintic*, &c., respectively. The number of variables (the function being homogeneous) is denoted by the words *binary, ternary*, &c. As a correlative term to coefficients, the variables have been termed *facients*. A function which is linear in respect to several distinct sets of variables separately is said to be *tantipartite*: or, when there are two sets only, *lineo-linear*. Thus a determinant is a tantipartite function of the lines or of the columns; the function $a\,x\,x'+b\,x\,y'+c\,x'\,y+d\,y\,y'$ is a lineo-linear function of (x,y) and (x', y'); a notation for it is

$$\left(\begin{matrix} a, & b \\ a', & b' \end{matrix}\right)(x, y)(x', y')$$

such as has been spoken of in regard to matrices.

Emanant.—The development of an expression such as

$$(*)(\lambda\,x+\mu\,x', \lambda\,y+\mu\,y')^m$$

is naturally written under the form

$$\begin{array}{llr} & (*)(x, y)^m & \lambda^m \\ + & \frac{m}{1}(*)(x, y)^{m-1}(x', y') & \lambda^{m-1}\mu \\ & \quad\vdots & \\ + & (*)(x', y')^m & \mu^m, \end{array}$$

and the coefficients of the successive terms λ^m, $\lambda^{m-1}\mu$, &c., are said to be the emanants of the quantic $(*)(x, y)^m$. The coefficients of λ^m, or 0-th emanant, is the quantic itself, and the coefficient of μ^m, or ultimate emanant, is the quantic with (x', y') in the place of (x, y); but the intermediate emanants are functions of (x, y) and (x', y') homogeneous in respect to the two sets separately. The coefficients may of course be expressed thus, the emanant (first emanant) of $(a, b, c)(x, y)^2$ is $(a, b, c)(x, y)(x', y')$, which stands for $a\,x\,x'+b\,(x\,y'+x'\,y)+c\,y\,y'$.

Linear Transformations.—In this theory the variables of a function are supposed to be respectively linear functions of a new set of variables, so that the function is transformed into a similar function of these new variables, with of course altered values of the coefficients, and the question was to find the relations which existed between the original and new coefficients and the coefficients of the linear equations. The determinant composed of the coefficients of the linear equations is said to be the *modulus of transformation*, and when this determinant is unity the transformation is said to be *unimodular*. It was observed that a certain function of the coefficients, namely, the discriminant, possessed a remarkable property, found afterwards to belong to it as one of a class of functions called originally *hyperdeterminants*, but now *invariants*, and it was in this manner that the problem of linear transformation led to the general theory of covariants.

Invariant.—An invariant is a function of the coefficients of a rational and integral homogeneous function or quantic, the characteristic property whereof is as follows: namely, if a linear transformation is effected on the quantic, then the new value of the invariant is to a factor *près* equal to the original value; the factor in question (or quotient of the two values) being a power of the modulus of transformation, and the two values being thus equal when the transformation is unimodular. The easiest example is afforded by the quadric function $(a, b, c)(x, y)^2$; effecting upon it a linear transformation, suppose that we have identically

$$(a, b, c)(\alpha\,x'+\beta\,y', \gamma\,x'+\delta\,y')^2=(a', b', c')(x', y')^2$$

then it may be easily verified that $a'\,c'-b'^2=(\alpha\delta-\beta\gamma)^2(a\,c-b^2)$. The invariant $a\,c-b^2$ is however in this case nothing else than the discriminant; as another example take the quartic $(a, b, c, d, e)(x, y)^4$, for which $a\,e-4\,b\,d+3\,c^2$, $a\,c\,e-a\,d^2-b^2d+2\,b\,c\,d-c^3$ are functions possessed of the like property of remaining to a factor *près* unaltered by the transformation, and are consequently invariants; it may be added that calling them I, J, respectively, the discriminant is here $=\mathrm{I}^3-27\,\mathrm{J}^2$, a rational and integral function of invariants of a lower degree.

Covariant.—Instead of a function of the coefficients only, we may have a function of the coefficients and variables, possessed of the like property of remaining unaltered to a factor *près* by the linear transformation: such function is termed a covariant. Thus, a covariant (the Hessian) of the quartic $(a, b, c, d, e)(x, y)^4$ is

$$(a\,c-b^2, 2\,a\,d-2\,b\,c, a\,e+2\,b\,d-3\,c^2, 2\,b\,e-2\,c\,d, c\,e-d^2)(x, y)^4.$$

The quantic itself is one of its own covariants. The term covariant may be used in contradistinction to, or as including, invariant. The terms invariant, covariant, have been explained in reference to the simple case of a single quantic containing but one set of variables, but they apply equally to the case of a system of quantics, and to quantics which are homogeneous functions of two or more distinct sets of variables. There is one case which it is proper to mention: if in conjunction with a quantic $(*)(x, y, z\,..)^m$ we consider a linear function $\xi x + \eta y + \zeta z + \ldots$, the invariants of the system are functions of the coefficients of the quantic, and of the coefficients $\xi, \eta, \zeta \ldots$ of the linear function; and treating these as facients, the invariant is said to be a *contravariant* of the given quantic.

The foregoing definition gives the characteristic property of a covariant, but it does not directly show how the covariants of a given quantic are to be investigated. This is supplied as follows:—For any quantic with arbitrary coefficients, for example $(a, b, c, d)(x, y)^4$, there exist operators involving differentiations in respect to the coefficients, tantamount to the operators $x\,d_y$ and $y\,d_x$ in respect to the variables; thus the operator $a\,d_b + 2\,b\,d_c + 3\,c\,d_d$ is tantamount to $y\,d_x$, and $3\,b\,d_a + 2\,b\,d_c + c\,d_d$ is tantamount to $x\,d_y$. Or what is the same thing, denoting for shortness these operators by $\left\{y\,d_x\right\}, \left\{x\,d_y\right\}$ respectively, the quantic is reduced to zero by each of the operators $\left\{y\,d_x\right\} - y\,d_x$, $\left\{x\,d_y\right\} - x\,d_y$. Any function of the coefficients and the variables which, in like manner with the quantic itself, is reduced to zero by these two operators respectively, is said to be a *covariant*; or, if it contains the coefficients only, an *invariant* of the quantic. That the two definitions lead to the same result is of course a theorem to be proved.

The leading coefficient of a covariant, say the coefficient of x^m in any covariant of a binary quantic $(*)(x, y)^m$, possesses the property of being reduced to zero by the operator $\left\{y\,d_x\right\}$, and has been termed a *peninvariant*, but a more appropriate term is *seminvariant*. An invariant is a function of a given degree in the coefficients, and a covariant is a function of a given degree in the coefficients and order in the variables, and they may be and are designated accordingly; thus, the above-mentioned invariants I, J of a binary quartic are called respectively the *quadrinvariant* and the *cubinvariant*, and the covariant of the same quartic is termed the *quadricovariant*, or if the distinction were required it would be termed the *quadricovariant quartic*. In these cases the designations are sufficient, but it is to be noticed that in general there is more than one invariant or covariant of the same degree or of the same degree and order, and that any such designation is only a generic, not a specific, name. An invariant or covariant may also be designated by a name referring to the mode of generation—for example, the discriminant. The name *catalecticant* denotes a certain invariant of a binary quantic of an even order: namely, it is a determinant, which, for the above-mentioned quartic function, is—

$$\begin{vmatrix} a, & b, & c \\ b, & c, & d \\ c, & d, & e \end{vmatrix}$$

(being in this particular case the cubinvariant), and the name *canonisant* denotes a certain covariant of a binary quantic of an odd order, namely, it is a determinant the terms whereof are linear functions of the coefficients, and which for the cubic $(a, b, c, d)(x, y)^3$ is

$$\begin{vmatrix} a x + b y, & b x + c y \\ b x + c y, & c x + d y \end{vmatrix},$$

(being for the particular case the Hessian or quadricovariant).

CANONICAL FORMS.—A binary quantic of an odd order $2m+1$ admits of being expressed as a sum of $(m+1)$ powers of linear functions, for example, the cubic $(a,b,c,d)(x,y)^3$ can be expressed in the form $(l\,x + m\,y)^3 + (l'x + m'y)^3$—this is the *canonical form* of a binary function of an odd order. And there is in like manner a form (not admitting, however, of a simple definition) which is taken as the *canonical form* of a binary quantic of an even order. The catalecticant and the canonisant present themselves in the problem of the reduction of a binary quantic to the canonical form.

BEZOUTIC MATRIX.—If V, W are any two binary quantics of the same order m, V', W' are what V, W become when the variables (x, y) of the two quantics are changed into (x', y'); then $(V\,W' - V\,W') \div (x\,y' - x'y)$ is a rational and integral homogeneous function of the degree $m-1$ in each of the two sets (x, y), (x', y'), and the coefficients taken in their natural square arrangement constitute the Bezoutic matrix. The determinant formed out of this matrix is in fact the resultant of the two functions, or equated to zero it is the equation obtained by the elimination of the variables from the two equations $V = 0$, $W = 0$. If V, W are the derived functions of one and the same binary quantic of the order m, then the corresponding matrix, being of course of the order $(m-2)$, is the Bezoutoidal matrix, and the determinant is then the discriminant of the single quantic.

It would be too long to explain the allied terms Bezoutiant, Cobezoutiants, Bezoutoid, Cobezoutoids.

TACTINVARIANT, RECIPROCANT.—A definition in the language of analytical geometry will be the most easily intelligible, and it can readily be converted into an analytical form and made applicable to any number of variables. The function of the coefficients which equated to zero expresses that the two curves $U = 0$, $V = 0$, touch each other, is an invariant, namely, it is the *tactinvariant* of the two functions U, V. And in particular, if, instead of the curve $V = 0$, we have the line $\xi x + \eta\,y + \lambda\,z = 0$, then the function which equated to zero expresses that this line touches the curve $U = 0$, is a contravariant, namely, it is the *reciprocant* of the function U.

FUNCTIONAL DETERMINANT, JACOBIAN, HESSIAN.—If V, W be quantics, then the determinant—

$$\begin{vmatrix} d_x V, & d_y V, & .. \\ d_x W, & d_y W, & \\ \vdots & & \end{vmatrix}$$

is the functional determinant, or Jacobian, of the quantics $V, W \ldots$ And if $V, W, \ldots$ are the derived functions of $d_x U, d_y U, \ldots$ of one and the same quantic U, then the determinant in question is the *Hessian* of the single quantic: the Hessian is in fact to the Jacobian what the discriminant is to the resultant.

CONCOMITANT, COGREDIENT, CONTRAGREDIENT.—The theory of linear transformations has been considered from a different point of view; instead of the variables of a function being *put equal* to linear functions of a new set of variables, they are considered as being *replaced* by a new set of variables, linear functions of the original variables. Two sets of variables may be so related that when the first set is thus replaced by a set of linear functions of themselves, the second set is also replaced by a set of linear functions of themselves, the co-efficients of the two sets of linear functions being related together in a definite manner; this is *concomitance*, or rather it is (what is alone here spoken of) *simple concomitance*. The two most important kinds of concomitance are, 1st. *Cogrediency*, that is, when the substitution on the second set of variables is identical with that upon the first set; 2nd. *Contragrediency*, that is, when the substitution on the second set of variables is the inverse or reciprocal one to that on the first set; it will make the notion of contragrediency clearer to remark that if the variables $x, y, \ldots$ and $\xi, \eta, \ldots$ are contragredients, then $x', y' \ldots$ (which are linear functions of $x, y\,..$) and $\xi', y' \ldots$ (which are linear functions of $\xi, \eta\,..$) are so related that $\xi' x' + \eta' y' + \ldots$ is $= \xi x + \eta y + \ldots$ It was from the consideration of contragredient variables that the notion of a contravariant was first derived, but as above remarked, the notion is really included in that of a covariant.

COMBINANT.—A combinant is a covariant (or invariant) of a set of quantics of the same order, which, besides being a covariant in the ordinary sense of the word, is, so to speak, a covariant *quoad* the system, that is, it remains to a factor *près* unaltered, when the quantics of the system are replaced by linear functions of themselves; the factor in question being a power of the determinant formed with the coefficients of the linear functions. For instance, if $U = (a, b, c)(x, y)^2$ and $U' = (a', b', c')(x, y)^2$, then $ac' - 2\,b\,b' + c\,a'$ is a function which, when for the original coefficients are substituted those of $\lambda U + \mu U'$, $\nu U + \rho U'$, is merely changed into $(\lambda\rho - \mu\nu)^2(a\,c' - 2\,b\,b' + c\,a')$, and it is therefore a combinant. It would appear that the notion of a combinant might be extended to the case of a system of quantics not of the same order, and that the resultant of the system of quantics could be brought under the extended definition of a combinant, but this is a point which has not been considered.

The principal text-books on the foregoing subjects, are—on determinants:—Spottiswoode's 'Elementary Theorems relating to Determinants,' 4to, London, 1851; Brioschi, 'Teorica dei Determinanti,' 4to, Pavia, 1854, translated into French by Combescure and into German by Schellbach; Baltzer, 'Ueber die Determinanten,' 8vo, Leipzig, 1857 (especially valuable for its references to the original sources). On elimination: Faà de Bruno, 'Theorie générale de l'elimination,' 8vo, Paris, 1859. And extending to nearly all the subjects: Salmon, 'Lessons introductory to the modern higher Algebra,' 8vo, Dublin, 1859. The memoirs on the different subjects are very numerous, and it was not thought expedient to give a list of them.

MATICA or MATICO, *Medical Properties of.* This name is applied to an astringent plant brought from Peru, where it has long enjoyed a high reputation for its styptic properties. Doubts exist as to the botanical origin of the plant, some ascribing it to a Labiate plant, resembling a *phlomis*, while others refer it to a piperaceous plant, and even assert that it is the *piper angustifolium* (Ruiz et Pavon, tab. 64, a), a native of Peru. By Miguel this plant is now referred to the genus Artanthe, separated from Piper, and is called *Artanthe elongata.* It is a Steffensia, according to Kunth (in Linnæa,' xiii. 609). The odour of the leaves, somewhat resembling a mentha, and the large quantity of volatile oil obtained from them, lend countenance to the opinion of its being a labiate plant; while the alternate position of the leaves in most of the specimens described entirely negatives this notion. The probability is, that two distinct plants pass under the name of Matico, which, though they have a distinct origin, have similar properties. Frequent instances of this are found in Brazil, where numerous plants are called *caa-peba;* and several, reputed antidotes to the bites of serpents, are all termed *quaco:* one of these is the *Eupatorium glutinosum*, Kunth. The analysis of the leaves seems to have been made on the piperaceous plant, which is stated to yield a drink employed by the Indians to produce effects similar to the bang obtained from the *Cannabis Indica.* Matico has been analysed by Dr. Hodges, who found it to contain, 1, chlorophylle; 2, a soft dark-green resin; 3, a brown colouring matter; 4, a yellow colouring matter; 5, gum, and nitrate of potash; 6, a bitter principle, *Maticine;* 7, an aromatic volatile oil; 8, salts; 9, lignin.

Cold water extracts, in about four hours, all the medicinal virtues of the plant, and is an eligible means of administering it. A tincture is also employed, and the powdered leaves are both given internally and applied externally. It does not owe its astringent properties to tannin: and it seems to exert a vital action on bleeding vessels, so as speedily to arrest the hæmorrhage. It has been used to check other discharges, such as the profuse expectoration and also the night-sweats of consumptive patients. Few drugs exert more than a temporary influence over these symptoms; but among such, Matico seems well entitled to attention. Still more potent is oxide of zinc in such cases.

MATICIN. A non-azotised bitter principle, of unknown composition, found in the leaves of the *Artanthe elongata*.

MATINS (from the Italian *mattina*, or the French *matin*, morning), strictly the first part in the daily service of the Romish church. Matins or mattins however were divided into two parts, which were originally distinct offices and hours; namely, the *noctum and matin lauds*. The *nocturns* or vigils were derived from the earliest period of Christianity. We learn from Pliny the younger, as well as from Justin Martyr, Tertullian, and various writers of the first three centuries, that the Christians in those times of persecution held their assemblies in the night, in order to avoid detection. On these occasions they celebrated the memory of Christ's death in the holy mysteries. When persecution had intermitted and finally ceased, although the Christians were able to celebrate all their rites, and did administer the sacrament in the day-time, yet a custom which had commenced from necessity was retained from devotion and choice; and nocturnal assemblies for the worship of God in psalmody and reading still continued. The monastic orders, which, in the 4th century, arose under Pachomius, Anthony, Basil, and others, in Egypt, Pontus, and Syria, tended to preserve this custom of nocturnal vigils; and in the following centuries we find, from the testimony of Cassianus, Augustine, and others, that the same custom remained in most parts of the East and West. In the 6th century Benedict, the great founder of monastic societies in the West, prescribed the same in his Rule; and nocturnal assemblies were common about that time, especially in monasteries. The *lauds*, or more properly *matin lauds*, followed next after the nocturns, and were supposed to begin with day-break. We find allusions in the writings of Cyprian, and all the subsequent fathers, to the morning as an hour of prayer; but whether there was in the 3rd century any assembly of the church for the purpose of public morning worship is uncertain. However, about the end of the third or beginning of the 4th century there was public worship at this hour, as we learn from the 'Apostolical Constitutions,' where we have the order of the service.

(Bingham's *Antiquities of the Christian Church*, b. xiii.; Palmer's *Origines Liturgicæ*.)

MATRASS, a glass chemical vessel, employed for the purpose of digesting, boiling, and distillation, and sometimes, while one is used as the body, another serves as the receiver in the last-mentioned operation. Florence flasks are very commonly used for these purposes, and they answer admirably, on account of the excellent nature of the glass, which is such as to resist the effects of sudden alterations of temperature. Sometimes matrasses are very conveniently formed with flat bottoms, instead of their being round as in oil-flasks.

MATRIX, or GANGUE. Metallic ores are seldom found unmixed in the places in which they occur; they not only accompany each other, but are frequently associated with useless stony bodies, and these are called the matrix, or gangue.

It also happens that ores in some cases become gangues with relation to more precious minerals; those which may be distinguished as metallic gangues are iron pyrites, spathose iron-ore, oxide of iron, hydrate of iron, and blende; the earthy gangues are usually quartz, felspar, limestone, carbonate of baryta, sulphate of lime, sulphate of baryta, and fluor-spar.

MATRONS, JURY OF. When a widow alleges herself to be with child by her late husband, and it is suspected that she is not pregnant, or not so by the husband, a writ de ventre inspiciendo may be obtained out of chancery, on behalf of the next heir, whose rights might be prejudiced by a supposititious, or spurious, child. Under this writ a jury of "discreet and lawful women" is impannelled, to try, by inspection of her person (et ubera et ventrem tractando), whether the widow is with child or not, and if with child, to inquire of the time of conception, and of that of the expected delivery. If the widow be found to be pregnant, the sheriff, on returning the writ, certifies the court of common pleas to this effect; whereupon the widow, unless she be remarried (in which case she is not to be taken from her husband), is to be kept in a castle, or other safe place, until her delivery, in order, as far as possible, to prevent any child being improperly introduced as the issue of the husband, to the disherison of the heir. (Bracton, lib. 2, cap. 32; Croke, Eliz., 566; 6 Vesey, 260; 21 Viner's 'Abr.', 547.)

In the parliament roll of 9 Edw. II. (1 'Rot. Parl.,' 353, 354), is a curious proceeding, instituted on the 13th July, 1315, by the sisters and coheirs of Gilbert de Clare, earl of Gloucester, who had died on the 30th June, 1314, to recover their inheritance out of the king's hands, notwithstanding the alleged pregnancy of the countess, his widow. At the parliament held in January following, (more than eighteen months after the death of the earl), the king's sergeants insisted that it was still the duty of the crown to retain possession of the estate for the benefit of the expected offspring, whose birth had *from natural causes* (permittente naturâ) been so long deferred; and it was not until Easter term, 1316, that the impediment was treated as removed.

A jury of matrons is also summoned to inquire into the fact of pregnancy in cases where a woman convicted of treason or felony, upon sentence of death being pronounced, pleads, in stay of execution, that she is with child. If the matrons impannelled to try this allegation find it to be true, the convict, whether she be married or unmarried, is respited until after her delivery. In some of the cases reported, the matrons have been directed to inquire whether the convict is *quick* with child; in other cases, and those by far more numerous, the inquiry seems to have been general, namely, *pregnant* or not pregnant. (Hawkins 'P. C.', book ii., cap. 51, sec. 9.) As the child is now known to have the same degree of fœtal life before as after the change of position which occasions the sensation called quickening, the latter form of the inquiry appears to be not only the more humane but also the more correct; more especially as the law has now rejected the distinction between quick and not quick, in cases of attempts to procure abortion. (7 Will. IV. & 1 Vict., c. 85, s. 6.) After delivery the convict is not to be executed without an award of execution by the court. But when called upon to say why execution should not be awarded against her, the convict cannot plead that she is again with child; such further pregnancy being considered not to be a sufficient ground for suspending, for a second time, the execution of the sentence. The jailor is, under such circumstances, punishable for his negligence. But if the ground of the first postponement was the preservation of the infant, there seems to be no reason why the life of the second child should be sacrificed. 'Blackst. Com.' by Christian, vol. iv. p. 395; by Kerr, iv. p. 465.

The form of proceeding where a woman alleges herself to be with child by her late husband, which is described in the passage of Bracton already referred to, is evidently taken from the Roman form of proceeding in a similar case, as described in 'Dig.' 25, tit. 4, "De Inspiciendo Ventre, custodiendoque Partu."

MATTER is the name given to every thing which is not mind. Such seems to be the only way of defining the word; and though the definition may appear to assume that mind is not matter, the contrary of which has been contended by the class of writers called materialists [MATERIALISM], yet it does not really do so. For whatever theory may be adopted as to the nature of mind, whether it be considered as a separate principle from matter, or merely as a different manifestation of the same principle, the word *mind* is indifferently retained; and our definition may consequently be at once reconciled with the materialist theory by paraphrasing it thus:—matter is the name given to the substance composing the universe, under all its different modifications, excepting only that one which is known by the name of mind.

Matter then is the name for that out of which all objects external to the mind are thought to be composed, the question being reserved, whether the mind is or is not composed of the same substance. What this substance is, to which the name of matter is given, we do not know, and have no means of knowing. Various speculations have been made as to its nature, and theories formed concerning the manner of its composition; but these have no better basis than conjecture. Other speculations have been made as to whether there is such a thing as matter or not; and some philosophers have seen in the solid world around us nothing but a creation of the mind. [BERKELEY, in BIOG. DIV.; IDEALISM.]

There is no need to enter here into any of these speculations. It is sufficient to know and say that man, subject to certain affections of his senses, is led to assign those affections to an external cause. This external cause is that which he calls matter. What this matter is in itself he knows not. He knows only its capability of producing in him certain affections, the ordinary affections of the five senses (sensations as they are called), and those which give the ideas of extension and resistance. Thus, having already supposed something without, he pronounces these to be qualities of that something; ignorant all the while what that something is, and knowing it only as the *substratum* of the qualities.

MATTHEW, ST., THE GOSPEL OF, is a canonical book of the New Testament, ascribed by the unanimous consent of the early Christian writers to the apostle Matthew.

It is not easy to determine the language in which this gospel was composed. That it was written in Hebrew (by which we are to understand the Syro-Chaldaic dialect spoken in Palestine in the time of Christ), and that it was composed for the Jewish Christians, is asserted by Papias (Eusebius, 'Hist. Ecc.,' iii. 39), Irenæus (*Ibid.*, v. 8), Origen (*Ibid.*, vi., 25), Eusebius (*Ibid.*, iii. 24), and Jerome ('Comment. in Matt.,' præf., and 'De Vir. Illust.,' c. 3); and their account is followed by others of the early Christian writers. On the other hand it is argued in favour of a Greek original that these testimonies are inconclusive, for that Papias was a weak and credulous man, and that the other writers merely followed his account; that we find no traces of the actual existence of the Hebrew Gospel of St. Matthew, for all the quotations in the works of the early fathers are made from the Greek copy which we now have; that explanations are introduced which would be useless to Jewish readers (see Matt., i. 23; xxvii. 33-46): that parallel passages of the Old Testament are generally quoted from the Septuagint; and that the Greek Gospel which we now have bears every mark of being not a translation but an original document. In order to reconcile these facts with the statements of the early writers. Bengel long ago, and others since, have supposed that there were *two* originals of the Gospel, one written in Hebrew for the Jewish converts, and the other in Greek for general use. This belief is gaining ground, and is supported by the facts that Greek was the common language of literature and business, and that Josephus wrote his history in both languages.

The date of St. Matthew's Gospel has been the subject of as much dispute as its original language. If it were written at first for the use of the Christians in Judæa, the date would probably be early; and it has been remarked that the exhortations which it contains to patience under persecution would be most acceptable to the Jewish Christians in their persecution by the Sanhedrim soon after the ascension of Christ. None of the early writers, except Irenæus, give any explicit testimony on the subject, but their statements appear to imply that this was the first written of the four Gospels, and also, what indeed Eusebius expressly asserts, that it was composed before Matthew left Judæa. On these grounds, and from the supposed improbability of the Christians remaining long without some written account of the life of Jesus, the general opinion has assigned it the date of about A.D. 41.

But Irenæus says that it was put forth while Peter and Paul were preaching at Rome and laying the foundations of a church there. ('Adv. Hær.,' iii. 1, in Euseb., 'Hist. Ecc.,' v. 8.) On the strength of this testimony Michaelis, Lardner, and others have fixed the date at A.D. 61 or 63, and Lardner has drawn an elaborate argument in favour of this date from the internal evidence of the book itself, in which he endeavours to show that Matthew understood many points in the Christian system which the Apostles did not understand till some considerable time after Christ's ascension. But as in these passages Matthew is recording the words and actions of Jesus, and not his own opinions, we cannot see any force in the argument.

Some of the advocates for a double original refer the Hebrew copy to the earlier date, and the Greek tó the later.

The genuineness, authenticity, and canonical authority of this Gospel are established beyond dispute by the unanimous testimony of Christian writers from the earliest age, and by its place in the ancient versions. But many critics have doubted the genuineness of the first and second chapters, chiefly on account of the difference between the genealogy of Christ in the first chapter, and that given by St. Luke (iii.), and other discrepancies between these chapters and Luke's account of the early life of Christ, and other internal difficulties, and also on the ground that they were omitted in the copies used by the Nazarenes and Ebionites, which however were undoubtedly corrupt. The chief arguments on the other side are, that these chapters are contained in *all* the ancient MSS. and versions, that they are referred to and quoted by several of the Fathers, that the particle δὲ at the beginning of the third chapter shows that something had gone before, and that the style of these two chapters agrees with that of the rest of the Gospel, especially in the manner of quoting the prophecies of the Old Testament.

St. Matthew was an Apostle and an eye-witness of the acts of Jesus, at least of those which were after his call. His narrative has therefore the highest degree of credibility. His style of narration is simple and effective, and he relates the discourses of Christ with clearness, and often with great energy.

(Lardner's *Credibility* and *Lives of the Apostles and Evangelists*; Cave's *Lives of the Apostles*; Kuinoel, *Comment. in Lib. Hist. N. T. Proleg. in Matt.*; Dr. Kitto's *Introduction to St. Matthew*, in *Pictorial Bible*, edit. 1849; and the *Introductions* of Michaelis, Eichhorn, De Wette, Hug, and Horne.)

MAUNDY THURSDAY, the Thursday preceding Easter, on which the king or queen distributes alms to a certain number of poor persons at Whitehall; so named from the *maunds*, or baskets, in which the gifts were formerly contained. It was also called Shere Thursday, as we read in the 'Festival' of 1511; because anciently "people would that day shere theyr hedes and clypp theyr berdes, and so make them honest agenst Easter-day."

The custom of the maundy is of considerable antiquity. Augustine, according to Du Cange, is first quoted for it. It was a charitable custom, and instituted in imitation of our Saviour's pattern of humility. Originally the bestower of the maund also washed the feet of a certain number of the recipients of the charity. This ceremony is still continued by the Pope in Rome. In England at least it was not entirely confined to royalty. In the earl of Northumberland's 'Household Book,' begun in 1512, fol. 354, we have an enumeration of "Al maner of things yerly yeven by my lorde of his maundy, ande my laidis, and his lordshippi's childeren."

James II. was the last of our kings who performed the ceremony of washing the feet in person. The queen's royal alms are now distributed on Saturday at the almonry office, to the maundy men and women placed on the supernumerary lists, owing to the difference of the ages between the late king and her present Majesty. Both men and women receive 2*l.* 10*s.*, and as many silver pennies as the queen has numbered years. To the men, woollen and linen clothing, shoes, and stockings are given; and to the women, in lieu of clothing, 1*l.* 15*s.* each. The maundy men and women also receive 1*l.* 10*s.*, a commutation instead of the provisions heretofore distributed.

Dr. E. D. Clarke, in his 'Travels in Russia,' 4to. Cambr., 1810, gives an account of the ceremonial of washing the feet of the apostles, as it is called, on this day at Moscow. "This," he says, "we also witnessed. The priests appeared in their most gorgeous apparel. Twelve monks, designed to represent the twelve apostles, were placed in a semicircle before the archbishop. The ceremony is performed in the cathedral, which is crowded with spectators. The archbishop performing all, and much more than is related of our Saviour in the 13th chapter of St. John, takes off his robes, girds up his loins with a towel, and proceeds to wash the feet of them all until he comes to the representative of St. Peter, who rises, and the same interlocution takes place as between our Saviour and that apostle."

(Brand's *Popular Antiq.*, edit. by Sir H. Ellis, 1841; Fosbrooke's *Encyclopædia of Antiquities*, p. 702.)

MAUR, ST., CONGREGATION OF, a celebrated society of Benedictines in France, who professed to follow the primitive rule of that order. It was first established in 1618. Pope Gregory XV., at the instance of Louis XIII., gave it his approval by his brief dated 17th May, 1621; and Urban VIII. granted it new privileges by a bull dated 21st January, 1627. The report of the sanctity of this congregation induced several bishops, abbots, and monks to submit their monasteries to the direction of its superior, so that the congregation at last became divided into six provinces, of which each contained about twenty religious houses. The most considerable were, St. Denys, St. Germain-des-Prés, St. Remi at Rheims, Marmoustier, St. Pierre de Corbie, Fleuri or St. Benoit sur Loire, Fescamp, and the Trinité de Vendôme. The monks, beside the rule of St. Benedict, had other particular statutes and constitutions, and were governed by a general-superior, assistants, and visitors, who held a general chapter every three years at Marmoustier. Those who have any acquaintance with the history and progress of learning in Europe will readily acknowledge the advantages which letters have derived from this famous congregation, whose researches took in the whole circle of sciences, philosophy excepted. Among its more eminent members in the 17th century may be enumerated Hugh Menard, Luc d'Acheri, Jean Mabillon, Thierri Ruinart, and Bernard de Montfaucon. Moreri gives a list of the general-superiors of this congregation from 1630 to 1756.

(Moreri, *Diction. Historique*, tom. vii.; *Histoire Littéraire de la Congregation de Saint Maur*, 1770, by Dom Tassin.)

MAUSOLEUM, is the general term applied to a sepulchral edifice. Originally, however, Mausoleum (Μαυσολειον) designated the magnificent structure erected at Halicarnassus, B.C. 352, by Artemisia, as the sepulchre of her husband, Mausolus, king of Caria. So far did this surpass in magnificence all similar structures, that in the time of Pausanias, mausoleum had come to be the generic term for a costly tomb. Recent researches have invested the Mausoleum of Halicarnassus with a new interest.

Pliny gives a somewhat minute description of the building (xxxvi., 5), from which it appears to have been oblong in plan, the north and south sides extending 63 feet, the ends or fronts being shorter. The *pteron* was, he says, surrounded by thirty-six lofty columns, above which, and of equal height, rose by steps a pyramidal roof, the apex of which was surmounted with a quadriga. The entire height was 140 feet: the entire circuit 411 feet. Pythis and Satyrus were the architects. The sculptures with which it was adorned were the work of Scopas, Bryaxis, Timotheus, and Leochares, each of whom executed the frieze of one of the sides: the quadriga being the work of Pythis. All the ancient writers who refer to it do so in terms of unbounded admiration; and in the time of Pliny, and for centuries after, it was regarded as one of the "wonders of the world." Gradually, however, it appears to have become ruinous; in part at least it was probably thrown down by an earthquake, and its destruction was nearly completed when, in 1404, the Knights of Rhodes took possession of Halicarnassus and employed the materials of the Mausoleum in the erection of the castle, or fortress, of San Pietro. Twice, within little more than a century, was the castle repaired or enlarged, the Mausoleum still serving as a quarry; yet until the last occasion (1522) a large portion of the lower part of the building, including much of the sculpture, must have remained standing, as it is particularly described (from the narrative of one De la Tourrette who was present at its final destruction) in the 'Funerailles des Romains, Grecs, &c.,' of Guichard (Lyon, 1581, as quoted by Messrs. Newton and Hawkins). Eventually Halicarnassus passed into the hands of the Turks, who gave to the place the name of the castle, which they corrupted into Budrum, and the very site of the famous sepulchre was forgotten. Archæologists, indeed, at various times, published their conjectures, and travellers once and again visited the spot in the hope of verifying them; but until within the last few years all was uncertainty.

The researches of Sir Charles Fellows in Asia Minor having called attention once more to the subject, the English government directed their ambassador at Constantinople, Sir Stratford Canning, if possible to secure the sculptures still existing in the Castle of Budrum from further injury; and he, having obtained a firman from the Sultan, caused them to be carefully removed and forwarded to the British Museum. They consisted of two or three mutilated statues and eleven slabs, which proved to be a portion of the frieze described by Pliny as containing the Amazonomachia, or Battle of the Amazons with the Greeks, a work of exceeding interest in the history of Greek art. Mr. C.

T. Newton, an assistant in the Department of Antiquities of the British Museum, now thoroughly reinvestigated the whole subject, and published the result of his inquiries in a paper which appeared in the 'Classical Museum,' vol. v. (1847). Later Mr. Newton visited Budrum, and having submitted a proposition for exploring the site of the Mausoleum which met with the approval of the government, he was appointed vice-consul at Mitylene; a firman was obtained from the Porte, empowering him to make the requisite excavations, and the English government (the Earl of Clarendon being then Foreign Secretary) supplied him with a ship-of-war, a body of sappers, an officer of engineers, and an accomplished architect as assistants, together with every requisite for the successful prosecution of the undertaking. The remarkable results of the explorations, so far beyond what the most sanguine had anticipated, have been published in the "Papers respecting the excavations at Budrum," presented to Parliament in 1858-59, and in various literary journals and proceedings of societies; but a more ample, thoroughly digested, and fully illustrated work on the subject, by Mr. Newton and Mr. Pullan, the architect associated with him, is announced as ready for publication. To that we must refer for further information. Here it will be enough to say that after one or two essays in the place commonly supposed to be the site of the Mausoleum, Mr. Newton commenced working on a spot indicated by Professor Donaldson, and soon found that he had come upon the actual site. The explorations were necessarily long and tedious. Mr. Newton had to purchase and remove several houses, to employ a large number of native hands, and to exercise great caution in his dealing with the Turkish authorities. But his labour was well repaid.

He found statues, bassi-relievi, columns, and other architectural features, all broken and fragmentary, and all heaped confusedly together; but all were patiently collected, sorted, and sent to England. Here by the skilful experts of the British Museum they were thoroughly examined, and in many instances from among the disconnected fragments whole figures have been with rare dexterity pieced together. Chief of these was the master-work,—a draped statue, 10 feet high, of Mausolus himself, which was in more than sixty pieces, and which were successively picked out, identified, and fitted together into perhaps the noblest work of its class in existence; while the relievi with those already in the Museum form an entire length of upwards of 80 feet of frieze, also in its way unrivalled. With these marbles thus diligently classified and arranged, and the explorations of Mr. Newton on the site, so much has now been discovered that not only has the actual site been identified beyond possibility of dispute, but the extent, dimensions, and character of the entire edifice have been so clearly elucidated, that, when one or two points are agreed upon, the architect will be able to restore as completely the Mausoleum of Halicarnassus as any other of the great buildings of antiquity.

A few words will show the results actually obtained. Mr. Newton having fortunately struck early upon an angle of the building was able to work down to the marble floor of its original foundation, and to trace the outline of its boundary walls. Hyginus mentions that the Mausoleum stood within a *peribolus*, or sacred enclosure, 1340 feet in circumference. This enclosure Mr. Newton found, and though, from part of the ground being occupied by buildings, he could not trace it throughout its extent, he was able to determine that instead of being oblong, as was supposed, it was a square, the sides of which were 337 feet, and that the Mausoleum occupied nearly the centre of the quadrangle. The foundations of the Mausoleum—which appear to have been laid on the site of a quarry which had been used as a cemetery—proved to be 126 feet by 107. The basement, the interior of which was built of a kind of green-ragstone, was 65 feet high and 112 feet long by 93 feet wide—making very nearly Pliny's 411 feet "totus circuitus." Its sides were decorated with the friezes (perhaps in two tiers) spoken of by Pliny. The peristyle consisted of thirty-six Ionic columns, which by the drums of the shafts, or frusta, it was ascertained were within an inch or two of the height named by Pliny (37½ feet, or 25 cubits). These columns surrounded a *cella* or temple (the pteron of Pliny) which was 63 feet by 46 feet: on the long sides were eleven columns, on the fronts nine—the actual space between the columns being exactly the same (7′ 4″) "as in the Temple of Minerva at Priene, which in other respects bears a great resemblance to the Mausoleum, was built about the same period, and not improbably by the same architect." (Newton). As to the remarkable pyramid described as rising above this pteron, Mr. Newton found a number of marble blocks or tiles, 2 or 3 feet broad, but of a uniform depth of 11¾ inches, and having on the upper side a groove, on the lower a flange, so as to joint firmly into each other. Twenty-four of these, with the quadriga and figures on the apex, make up almost exactly the 37½ feet of the ancient description. These blocks, however, when protracted, as shown in the restoration of Mr. Newton and Lieut. Smith, render necessary a space of 22½ feet from the centres of the columns to the walls of the cella in order to allow adequate extension to the base of the pyramid. This, besides the unusual extent to be borne without visible means of support—and which presents a great constructive difficulty—gave so flat a pyramid as to have a somewhat ungraceful appearance; and Mr. Fergusson has accordingly very acutely suggested that the pyramid instead of having the usual flat sides was curvilinear in outline, like the roofs of the Lycian tombs. This would afford a better outline and seem to suit better Pliny's resemblance of the
pyramidal roof to a meta; but it has its difficulties, and th
must be regarded as at present unsettled: in other respect
does not seem to be much difference of opinion. Mr. Pullan, h
who supposes that by the pteron Pliny intended the peristyle a
the cella, believes that he shall be able, in Mr. Newton's forth
work, to put forth a restoration that will satisfactorily meet the
difficulties. The core of the basement, as we have seen, was of
ragstone; but all that was visible of the entire building was of
—coloured, however, as Mr. Newton thinks, from the traces h
covered, with the brightest blue and vermilion. Altogether, thi
remarkable resuscitation has abundantly confirmed the statemen
ancient writers as to the surpassing beauty and splendour o
unique edifice.

The vast collection of fragments of the Mausoleum brought to
country, is as present placed in a temporary enclosure under the p
of the British Museum, and not yet open to the public inspec
They comprise, as we said, a very large quantity of miscellaneous a
tectural fragments of great interest to the architect and arch
gist, and many valuable sculptural remains. These last inc
portrait statues of Mausolus and Artemisia—probably the
ancient examples of Greek portrait-statuary yet discovered, and
admirable as works of art. There are besides a colossal se
female figure, a male torso, and fragments of several other stat
Of equal interest with the Mausolus, but in another way, are
portions of two of the horses of the quadriga, which are larger
scale (they stood 10 feet high) than any other ancient marble horse
discovered, and (allowing for the altitude at which they were plac
hardly inferior in style to the famous horses of the Parthen
while the interest attached to them is not a little increased by
head retaining its original bronze bridle and accoutrements—the o
instance known of this kind of decoration (though often referred to
ancient writing) which has come down to the present time. Anoth
important fragment is that of the body of a horse and the torso
its rider, of colossal size, and of the most admirable design.
the frieze, altogether 80 feet in extent, it is said by Mr. Newton th
"no museum can show so magnificent a series of high relie
Besides these, there are six figures of lions in very tolerable pr
servation, and several fragments of lions, and broken portions of th
frieze.

The Mausoleum erected at Babylon by Alexander the Great, i
honour of Hephæstion, appears to have been equally magnificent with
that at Halicarnassus, but less refined, and indeed somewhat extravagant in its decorations, as far as can be gathered from the accoun
given of it by Diodorus (xvii. 115). It was adorned below by the gilded rostra, or beaks, of two hundred and forty ships, and every successive tier or story was enriched with a profusion of sculpture representing various animals, fighting centaurs, and other figures, all of which were gilt; and on the summit were statues of sirens, made hollow, in order that the singers who chanted the funereal dirge might be concealed within them.

The Mausoleums of Augustus and Hadrian at Rome were structures of great magnitude and grandeur, and resembled each other in being circular in plan. The first stood in the Campus Martius, where remains of it yet exist in the two concentric circles forming the first and second stories of the building, and the vaulted chambers between, which supported the first or lowest terrace. Of these terraces there were three; consequently four stages in the building, gradually decreasing in diameter, the uppermost of which was crowned by a colossal statue of the emperor. The terraces themselves were planted with trees.

Hadrian's Mausoleum, now converted into the Castello di S. Angelo, in which shape it is familiar to almost every one, is a work of massive construction, and originally presented an unbroken circular mass of building, erected upon a larger square basement, lofty in itself, yet of moderate height in proportion to the superstructure, the latter being about twice as high as the former. This nearly solid rotunda, which was originally coated with white marble, had on its summit numerous fine statues, which were broken to pieces and the fragments hurled down by the soldiers of Belisarius upon the Goths, who attempted to take the building by storm. Neither are any remains now left of the uppermost stage of the edifice, which assumed the form of a circular peripteral temple, whose diameter was about one-third of the larger circle. According to tradition, its peristyle consisted of the twenty-four beautiful marble Corinthian columns which afterwards decorated the Basilica of San Paolo fuori delle Mura; and its tholus or dome was surmounted by a colossal pine-apple in bronze, now placed in the gardens of the Vatican.

Such places as Henry VII.'s Chapel and the Pantheon of the Escurial may also be considered as mausoleums; but the term is generally restricted to a detached edifice erected merely as a private burying-place or to contain tombs. There are several structures of the kind in the parks of our nobility; among the more remarkable is that at Castle Howard, the seat of the Earl of Carlisle, and one of Hawksmoor's best works, a circular edifice in the Roman-Doric style, elevated upon a basement, and crowned by a dome: plans, sections, &c., of this structure have been beautifully engraved by Moses. The Marquis of Rockingham's mausoleum by Carr is another ornamental structure of the kind, composed of three stories, Doric, Ionic, and

Corinthian. We may also mention those at Cobham in Kent, and Brocklesby in Lincolnshire, by the late James Wyatt.

MAUVE. A new lilac colour or dye, obtained from aniline by Mr. Perkin. [COLOURING MATTERS.]

MAXIMA and MINIMA. These Latin words, which simply mean "greatest" and "least," are used to imply, not the absolute greatest and least values of a varying quantity, but the values which it has at the moment when it ceases to increase and begins to decrease, or *vice versâ*. Thus, if it be said that the height of the barometer was a maximum at ten o'clock, it means that up to that hour the barometer rose, and then began to fall; in which case it would still be said to have been a maximum, even though it should afterwards rise, and stand at a greater height than that at ten o'clock. Thus it is possible that there should be several maxima and minima in one day, and even that one of the minima should be greater than one of the maxima: that is, at one moment when the fall ceases and a rise begins, the barometer may then be higher than it was at another time when a rise had ceased and a fall began.

The theory of maxima and minima is, mathematically speaking, very simple. It is obvious, from the definition of a differential coefficient, that if y be a function of x, and if x be increasing, then when y also increases, $\frac{dy}{dx}$ is positive; and when y diminishes, $\frac{dy}{dx}$ is negative. If the words increase and diminution have their full algebraical sense, this proposition is true whatever the sign of y may be. It follows that when increase ceases and diminution begins, $\frac{dy}{dx}$ changes from positive to negative, and when diminution ceases and increase begins, it changes from negative to positive. But as a quantity cannot change its sign without becoming either nothing or infinite, it follows, first, that y can only be a maximum when x has such a value that $\frac{dy}{dx}$ is nothing or infinite; secondly, that there is not then a maximum unless the latter change from positive to negative, when x increases through that value; nor a minimum unless the same differential coefficient change from negative to positive, in the same case.

Thus when $y=a+x-x^2$, the differential coefficient of which is $1-2x$, we see that the latter changes sign when x changes from less than $\frac{1}{2}$ to greater than $\frac{1}{2}$; and the change of sign is from positive to negative. There is therefore a maximum when $x=\frac{1}{2}$, and this maximum is $a+\frac{1}{2}-\frac{1}{4}$, or $a+\frac{1}{4}$.

When $\frac{dy}{dx}=0$ (which is by far the most common case), and there is a maximum, it changes sign from + to −, or diminishes, algebraically speaking: therefore $\frac{d^2y}{dx^2}$ is negative. Similarly, when $\frac{dy}{dx}=0$, and there is a minimum, $\frac{d^2y}{dx^2}$ is positive. But when $\frac{dy}{dx}$ is infinite, and there is a maximum or minimum, this additional rule does not apply.

Works on the differential calculus give the development of this theory and examples. We shall here only add one of the rules for determining the maximum or minimum when there are two distinct variables.

When z is a function both of x and y, two variables independent of one another, there may be a maximum or minimum when $\frac{dz}{dx}$ and $\frac{dz}{dy}$ are both nothing, both infinite, or one nothing and the other infinite. When they are both nothing, which is the only case in which this theory is of any practical application, it must be determined as follows whether there be any maximum or minimum, and which it is. Find the values of x and y which make $\frac{dz}{dx}=0$, $\frac{dz}{dy}=0$, and with any pair of these values find the value of the expression

$$\left(\frac{d^2z}{dx\,dy}\right)^2-\frac{d^2z}{dx^2}\cdot\frac{d^2z}{dy^2}.$$

If this be negative, or nothing, there is a maximum or minimum; if it be positive, there is a mixture of the two which can only be satisfactorily explained by illustrations drawn from the theory of curved surfaces. When the expression is negative or nothing, there is a maximum if $\frac{d^2z}{dx^2}$ and $\frac{d^2z}{dy^2}$ be both negative, and a minimum if they be both positive.

The usual method of establishing all the preceding formulæ, namely, by the application of Taylor's theorem, applies only to the cases in which the differential coefficients become nothing, and not to that in which they become infinite. It is also frequently stated that there is always a maximum or minimum when a differential coefficient vanishes, which is not true.

MAXIMUM IN MACHINES. [MACHINE.]

MAY, the fifth month of our present year, was the second in the old Alban calendar, the third in that of Romulus, and the fifth in the calendar of Numa Pompilius. In the Alban calendar it consisted of twenty-two days; of thirty-one in the calendar of Romulus; and of thirty in that of Numa. Julius Cæsar restored to it the odd day of which Numa had deprived it, and of which it still keeps possession. Its etymology is doubtful. Ovid, in the fifth book of his 'Fasti,' proposes three derivations: one from *majestas*; another from *majores*, a term which signified the *patres*, or governing body of the city of Romulus; and the third from *Maia*. The Roman month was under the protection of Apollo; and on account of the celebration of the Lemuria, marriages undertaken during its course were considered ill-omened. (Ovid, *Fasti*, v. 488-490.)

Our Saxon ancestors, after the Romans, called it *Maiusmonth*; and, in their native language, *threo-meolce*, three-milk month, when cows were milked three times a day.

MAY-DAY and MAYING. It was anciently the custom, observes Brand, for all ranks of people to go out a-maying early on the 1st of May. Bourne ('Antiq. Vulg.', ch. xxv.) tells us that, in his time, in the villages in the north of England, the juvenile part of both sexes were wont to rise a little after midnight on the morning of that day, and walk to some neighbouring wood, accompanied with music and the blowing of horns, where they broke down branches from the trees, and adorned them with nosegays and crowns of flowers. This done, they returned homeward with their booty about the time of sunrise, and made their doors and windows triumph in the flowery spoil.

There was a time when this custom was observed by noble and royal personages as well as the vulgar. Chaucer, Shakspere, Browne ('Britannia's Pastorals'), and other writers in verse and prose, have described or alluded to the popular celebration of the day. The maypole was raised in every town and village, and milk-maids and morris-dancers danced round it. These customs gradually fell into disuse; and in London the celebration of the day was left to the chimney-sweepers, whose representatives still in London and its suburbs struggle for an existence with their Jack-in-the-green and their tawdry finery. In many country villages, however, the observance of May-day is kept up on a small scale, by children carrying from door to door garlands of paigles (or cowslips), blue-bells, and other field flowers; and in some places there is a feeble imitation of "going a-maying." (See Notes and Queries, 1st series, passim.)

In the Highlands of Scotland the 1st of May was celebrated as *Bel-tein* day, on which they made a fire, and performed certain puerile ceremonies, which are supposed to have had reference to the worship of *Baal*, or the sun. The Irish celebrated it by having a peculiar dish of food, the partaking of which they imagined secured them against want for the year. The Germans imagined that on the night of this day the witches had an assemblage on the Brocken in the Harz mountains. In France and Italy the youth of both sexes gathered branches in the night, which they placed before the doors of those to whom they wished to show good-will. There were many other superstitious observances connected with this day, nearly all of which are now obsolete, or about to become so.

The celebration of this day probably owed its origin to the heathen observances practised at this season of the year in honour of Flora, the deity who presided over fruits and flowers. (Hospinian, *De Festis Judæorum et Ethnicorum*, fol. 100; Brand's *Popular Antiquities*; Strutt's *Sports and Pastimes*; Hone's *Every Day Book*.)

MAYOR. [MUNICIPAL CORPORATIONS.]

MEADOWS are properly low grounds on the banks of rivers, which, being kept moist by their situation, and also occasionally flooded by the rise of the waters, are best adapted for the growth of grass, and are generally mown for hay. Some meadows of great extent, belonging to a community or district, in which every inhabitant has a right to send his cattle to graze, under certain regulations, are never mown.

When the number of those who have a right of common pasture is not very great, they frequently agree among themselves to abstain from depasturing the meadows in spring, and, dividing them into portions, each makes hay of his share; after which the cattle are admitted in common for the remainder of the season. Thus a common meadow is converted into a *Lammas meadow*, that is, a meadow which becomes a common pasture after the 1st of August, this being the time when it is supposed that all the hay has been made and secured.

When meadows are private property they become much more valuable. The flooding is encouraged or prevented, according to circumstances, and in many cases artificial irrigation is adopted. [IRRIGATION.] If they are exposed to be too often inundated, they are protected by dams and sluices.

The herbage of low wet meadows is generally coarser and less nutritious than that of those which lie higher: hence upland hay, as it is called, is preferred for the better sort of cattle. Good grass land, to which the floods never rise, is often called meadow land when the natural herbage is permanent, and frequently made into hay.

Upland meadows are very valuable wherever there is a demand for good hay. A considerable degree of attention is required to make them most productive. Not being annually recruited by flooding, they would soon degenerate if some pains were not taken to keep up their natural fertility. This may be done in various ways: the most obvious is to recruit them frequently with the richest animal and vegetable manure, which, being spread over the surface at a time when showers are abundant, that is, either early in spring or immediately after midsummer, is washed down to the roots of the grass. A rapid growth is thus produced, which is soon perceived by comparing the appearance of a meadow which has been manured with that of one left in its natural state. It has been asserted by many agricultural authors that the produce of hay is greater when the meadows are mown every year, provided they be occasionally manured, than when mown and depastured alternately. But the productiveness of a meadow depends entirely on the circumstances of soil and situation. A meadow, the soil of which is naturally of a rich nature, and adapted to produce fine grasses, may be mown year after year without any perceptible change in the quality of the hay; while another of inferior quality requires to be occasionally cropped close, to check the growth of the coarser grasses, and to allow the finer to rise. As to the effect of taking off the hay by mowing it, compared with that of the bite of cattle, there is little difference, except that in pasturing the grass is repeatedly cropped close to the ground as soon as it rises to such a height that the teeth of the cattle can sever it. It consequently spreads by the roots, and the pile becomes closer. The urine of the cattle greatly promotes luxuriant vegetation in rainy weather, but in hot dry weather it does more harm than good. The dung, when dropped on the grass, is of little or no value compared with what it would be if mixed up with straw, earth, or peat, or diffused through water in a tank. It is therefore an excellent practice to employ women and children to collect the fresh dung in the pastures, and to carry it to a heap of earth where it may be covered up, or to a tank where it may be diluted with water.

Of late years the practice of *soiling* has been extensively adopted; that is, all the grass is mown and carried every day, in a green state, to cows or horses tied up in a stable. By this means all the advantage of mowing for hay is obtained, besides an abundant supply of rich manure, which can be applied to the land in a liquid and diluted state, when its effect is powerful and certain. So much more fodder is produced from the land by the system of soiling, that arable fields are converted into artificial and temporary meadows, in which the different species of grasses are sown, in order to be cut green or made into hay; and when, from the nature of the soil, the herbage degenerates, the field being ploughed up again is greatly improved by this change of cultivation. [Grass-Land.]

When a natural meadow has been neglected, and the grass is of an inferior quality, and mixed with rank weeds and moss, it requires much care to restore it to its original fertility. In most cases the shortest method and the best is to plough it up, clean and manure it during a course of tillage, without taking very exhausting crops from it, and then to lay it down again in a clean and enriched state, by sowing the best sort of grass seeds; or, which is preferable, by inoculating, or planting in it small tufts of grass from some rich meadow, which will soon increase, and produce a new and improved sward. But where the soil is a very stiff clay, with only a small depth of good mould over it, there is some danger in breaking the old sward, for it will take a long time and much manure to reproduce a proper covering of grass. In this case it is a preferable practice to scarify the meadow, by means of instruments which do not go deep, but only tear up the surface. If this is done early in spring, when the ground is moist, and the whole surface is brought to resemble a fallow field, good grass seeds may be immediately sown. If rich manure, mixed with lime or chalk, be then spread over the land, and the whole well harrowed and rolled, the old and young grass will spring up together, and show a wonderful improvement in a very few months. It is prudent to mow this renovated meadow before the seeds of the grasses are formed, contrary to a common notion that in a thin meadow the seed should be allowed to shed, in order to increase the number of plants. The notion is good, but it should be done by sowing seed produced on other ground: for the ripening of the seed tends to exhaust the soil. If the grass be cut before the flower is faded, the roots will soon spread, and produce a new and improved sward.

It must be observed that it is not indifferent what cattle are turned into the meadow after hay-making. Horses invariably produce coarse weeds by their dung and urine; cows may be depastured in autumn, as long as the surface is dry; but sheep are far more advantageous, and may be kept in the meadows at all times, if they are not too wet for the health of the sheep, and if there is no danger of their having the rot.

MEAN. By the mean of two or more quantities is meant an intermediate quantity determined by mathematical rules. There are more ways than one of finding a mean, but the two principal results of this kind are called the *arithmetical* and the *geometrical* means. The names are not properly expressive of the distinction between them, but they are established by use.

An arithmetical mean is the simple AVERAGE, formed by adding the quantities together, and dividing by the number of quantities. A geometrical mean is the square root of the product of the quantities. Generally, let there be a number of quantities, x_1, x_2, x_3, &c., and let $\phi(x_1, x_2, x_3, \&c.)$ be a function of them which is symmetrical, that is, which is not altered when any two of them are interchanged; then if y be found from the equation

$$\phi(y, y, y, \&c.)=\phi(x_1, x_2, x_3, \&c.),$$

y may be called a species of mean.

The arithmetical mean, or average (which is always to be understood when the word mean is mentioned, unless the contrary be specified), is taken to be the most probable result of a number of discordant quantities, which would have been the same but for errors of observation or experiment. Thus if three measures of the same length give 122, 123, and 123·4, the mean of which is 122·8, it is presumed that 122·8 is more likely to be the real length which was attempted to be measured than any other. We confine ourselves in the present article to pointing out how it may be ascertained what degree of probability belongs to such results.

In assuming the average as the most probable result, it is presumed that any one measurement is as likely to err one way as the other; that is, as likely to be too small as too great. If nothing but results be known, this presumption is justifiable; but if it be known that there is more tendency to error of one sort than the other, the most probable result cannot be ascertained until it is found out by how much the average of a very large number of observations would be affected by this tendency. Say it is known that in the long run the average will be increased ·3 above the truth by a greater tendency to measure too much than too little; then 122·8 − ·3, or 122·5, is the most probable result of the preceding three observations.

It is obvious that when observations nearly agree with each other, the average must be nearly the truth required, and the nearer the agreement of the observations, the more nearly. If the observations do not agree well, the average is still more likely than anything else, but not so likely as before.

We now show how, having a number of observations, to determine the probability that the truth lies within a given degree of nearness to the average. A table must be used, which we here give to a greater extent than we should otherwise do, on account of succeeding articles. Let M be the average of a number of observations, and let $M+m$ and $M-m$ be the limits of which it is required to know what is the chance of the truth being between them. Take the difference between M and each of the results of observation, and add the squares of these differences. Multiply 100 times the number of observations by m, and divide by the square root of twice the sum just found: take the number nearest to the result in the column marked A, and opposite to it, in the column marked B, will be found the number of chances out of 10,000 for the degree of nearness required.

A	B	A	B	A	B	A	B	A	B	A	B
1	113	36	3893	71	6847	106	8661	140	9523	174	9861
2	226	37	3992	72	6914	107	8698	141	9539	175	9867
3	338	38	4090	73	6981	108	8733	142	9554	176	9872
4	451	39	4187	74	7047	109	8768	143	9569	177	9877
5	564	40	4284	75	7112	110	8802	144	9583	178	9882
6	676	41	4380	76	7175	111	8835	145	9597	179	9886
7	789	42	4475	77	7238	112	8868	146	9611	180	9891
8	901	43	4569	78	7300	113	8900	147	9624	181	9895
9	1013	44	4662	79	7361	114	8931	148	9637	182	9899
10	1125	45	4755	80	7421	115	8961	149	9649	183	9903
11	1236	46	4847	81	7480	116	8991	150	9661	184	9907
12	1348	47	4937	82	7538	117	9020	151	9673	185	9911
13	1459	48	5027	83	7595	118	9048	152	9684	186	9915
14	1569	49	5117	84	7651	119	9076	153	9695	187	9918
15	1680	50	5205	85	7707	120	9103	154	9706	188	9922
16	1790	51	5292	86	7761	121	9130	155	9716	189	9925
17	1900	52	5379	87	7814	122	9155	156	9726	190	9928
18	2009	53	5465	88	7867	123	9181	157	9736	191	9931
19	2118	54	5549	89	7918	124	9205	158	9745	192	9934
20	2227	55	5633	90	7969	125	9229	159	9755	193	9937
21	2335	56	5716	91	8019	126	9252	160	9763	194	9939
22	2443	57	5798	92	8068	127	9275	161	9772	195	9942
23	2550	58	5879	93	8116	128	9297	162	9780	196	9944
24	2657	59	5959	94	8163	129	9319	163	9788	197	9947
25	2763	60	6039	95	8209	130	9340	164	9796	198	9949
26	2869	61	6117	96	8254	131	9361	165	9804	199	9951
27	2974	62	6194	97	8299	132	9381	166	9811	200	9953
28	3079	63	6270	98	8342	133	9400	167	9818	210	9970
29	3183	64	6346	99	8385	134	9419	168	9825	220	9981
30	3286	65	6420	100	8427	135	9438	169	9832	230	9989
31	3389	66	6494	101	8468	136	9456	170	9838	240	9993
32	3491	67	6566	102	8508	137	9473	171	9844	250	9996
33	3593	68	6638	103	8548	138	9490	172	9850	260	9998
34	3694	69	6708	104	8586	139	9507	173	9856	270	9999
35	3794	70	6778	105	8624						

Suppose, for example, that seven observations give 10·03, 10·71, 10·98, 10·26, 10·30, 10·72, 10·81, the average of which is 10·54, differing from the respective observations by ·51, ·17, ·44, ·28, ·24, ·18, and ·27, the sum of the squares of which is ·7239, twice which is 1·4478, the square root of which is 1·203. Let it be required to find the chance of the truth lying between 10·54 + ·06 and 10·54 − ·06, we have then to multiply 700 by ·06, which gives 42, and to divide by 1·203, which gives 34·9. Opposite to 35 in the column A is found 3794, so that 3794 out of 10,000, or 3794 to 6206 is the chance of the result lying between the limits given: that is, nearly 31 to 19 against it. If the limits proposed had been 10·54 + ·1 and 10·54 − ·1, 700 multiplied by ·1 and divided by 1·203 would have given 58·2. Opposite to 58 in the table we find 5879, so that it is 5879 to 4121, or about 59 to 41, in favour of the result lying between 10·64 and 10·44.

In the preceding rule it is supposed that all the observations are equally trustworthy, or that there is no circumstance which would beforehand lead us to suppose that any one is more likely to be true than another. If this be not the case, no rule can be applied except one which depends on the observer's judgment. He must make the different observations reckon as different numbers of observations, allowing any one observation to count as more than one, if he believes it to be better than the rest. Thus, suppose three observations to give 26, 28, and 29, and that it is thought there is reason to prefer 28 to the others, and 29 to 26, so that 28 ranks in the observer's mind as being as good as a mean of eight observations, 29 of six, and 26 of four. It must then be considered that there have been 8 + 6 + 4, or 18 observations, of which 8 have given 28, 6 have given 29, and 4 have given 26. These numbers, 8, 6, and 4, are called the *weights* of the several observations 28, 29, and 26, and the alteration in the preceding rule is as follows:—In forming the average, multiply each observation by its weight; add the result, and divide by the sum of the weights. Thus $8 \times 28 + 6 \times 29 + 4 \times 26 = 502$, which divided by 8 + 6 + 4, or 18, is 27·89, the most probable result. In finding the probability of the truth lying within given limits on one side or the other of this most probable average, let the average be M as before, and the limits $M + m$ and $M - m$; take the difference between M and each of the results of observation, multiply the square of each difference by the weight of its observation, and add the results. Multiply 100 times the sum of the weights by m, and divide by the square root of twice the sum just found; take the number nearest to the result in the column marked A, and opposite to it in the column marked B will be found the number of chances out of 10,000 for the degree of nearness required. Thus if in the preceding instance we ask what is the chance of the truth lying between 27·89 + ·2 and 27·89 — ·2, we observe that 27·89 differs from the several results by 1·89, ·11, and 1·11, the squares of which multiplied by 4, 8, and 6, and the results added together, give 21·7778, twice which is 43·5556, the square root of which is 6·600. And 100 times the sum of the weights, or 1800, multiplied by ·2, is 360, which divided by 6·6 gives 54·6. Opposite to 55 in column A we find 5633 in column B; that is, we have 5633 to 4367, or about 56 to 44 in favour of the truth lying between the limits specified.

The inverse problem is as follows: given the observations, required the limits of difference from the average between which it is a given chance, a to b, that the truth shall lie. In both cases the first process is to turn $a : (a + b)$ into a decimal fraction of four places, and to take the numerator of such fraction.

Look for the numerator in column B, find the number nearest to it, and take out the number corresponding in column A. Multiply this by the square root used in the direct rule, and divide by 100 times the number of observations, or, if they are not equally good, by 100 times the sum of the weights. The quotient is the answer required. But when, as most frequently happens, an even chance is the given chance, use 47·7 instead of the number found in column A.

In the first of the given instances it is required to know within what limits it is 99 to 1 that the truth is contained. Here 99 : (99 + 1) is ·9900, and looking for 9900 in column B we find 9899 opposite to 182 in column A. Multiply 182 by 1·203, which gives 218·946, which divided by 700 gives ·313, so that it is 99 to 1 that the truth lies between 10·54 + ·313 and 10·54 — ·313.

In the second instance, required the limits within which it is an even chance that the truth is contained. Multiply 47·7 by 6·6, and divide by 1800, which gives ·175; and it is an even chance that the truth lies between 27·89 + ·175 and 27·89 — ·175.

The amount of departure from the average within which, on one side or the other, it is an even chance that the truth shall lie, is called the *probable error* of the observation or average of observations to which it refers. When the probable error of any one observation is given, that of the average is found by dividing it by the square root of the number of observations. Thus, if there be 100 observations, of each of which it is an even chance that it is within ·1 of the truth; then the square root of 100 being 10, and ·1 ÷ 10 being ·01, it is an even chance that the average of the hundred observations is within ·01 of the truth.

For further account of the matters contained in this article, see Probabilities, Theory of; Observation; Risk. For description of methods without demonstration, see Lardner's *Cabinet Cyclopædia*, Essay on Probabilities, or Poisson on Probabilities. The tables may be found to greater extent in the first article cited, and also in the Berlin *Astronomisches Jahrbuch* for 1834.

MEASLES (*Morbilli*, *Rubeola*) is the popular name of a contagious disease, characterised by an eruption on the skin, and affecting chiefly children.

The etymology of the word measles is uncertain, but its application to the disease we are treating of was probably borrowed from an appearance so denominated in pork, to which the eruption bears resemblance. Measles is ushered in by more or less fever, a running from the nostrils and eyes, with some inflammation of the latter, sneezing, hoarseness, a dry cough, difficulty of respiration, and occasionally slight soreness of the throat. From four to six days after the commencement of these symptoms a rash begins to appear, which first shows itself in distinct, red, and nearly circular spots, having some resemblance to flea-bites: these spots gradually coalesce and form small slightly elevated patches of an irregular figure, but approaching nearest to that of semicircles or crescents. The patches first show themselves on the forehead and face, and gradually extend downwards to the trunk and extremities At the commencement of the eruption the catarrhal symptoms and fever are somewhat augmented, and during its height the whole face is often swollen and the eyelids thereby closed; on its decline, which begins on the fourth or fifth day, the fever ceases, and from those parts of the body previously covered by eruption the cuticle separates in small bran-like scales. A diarrhœa now commonly supervenes, and affords relief to the other symptoms. This, however, is the period when the danger, which is a consequence rather than a concomitant of measles, commences. The cough, which has continued throughout the active period of the disease, now assumes a more serious character; the expectoration, which hitherto has been simply mucus, indicative of the inflammation being confined to the mucous membrane of the bronchial tubes, becomes bloody, or mixed with pus, showing either that inflammation has attacked the proper substance of the lungs, or that tuberculous deposits have taken place in these organs, constituting pulmonary consumption. If the patient happily escape these dangers, others, less fatal indeed, but scarcely less to be dreaded, not unfrequently show themselves, among the most severe of which are obstinate ophthalmia and inflammation of the internal parts of the ear, the former not unfrequently terminating in partial or total loss of vision, and the latter in deafness. It must be confessed, however, that this is a picture rather of what may and occasionally does happen than of what takes place in the majority of instances; such severe terminations of the disorder are confined chiefly to the ill-fed and ill-clad children of the poor, and to the more sickly ones of the opulent.

Measles frequently occurs as an epidemic, in this country usually at the beginning of spring. These epidemics vary considerably in character, being sometimes benign, at other times very fatal, and occasionally they are observed to prevail in conjunction with small-pox; like the latter disease, measles rarely attacks the same individual twice. Experiments have been made to determine how far inoculation with the blood of the parts on which the eruption appeared might succeed in moderating the violence of the disease thus artificially produced; but the cases in which it was tried were not sufficiently satisfactory to warrant its general adoption. Measles, before the outbreak of the rash, may be mistaken for severe catarrh; the eruption itself is liable to be confounded with that of roseola, scarlatina, strophulus, lichen, urticaria, incipient small-pox, &c.; but the crescentic shape of the patches and the catarrhal character of the other symptoms can hardly fail to remove any doubt as to the nature of the disease.

With respect to the treatment, little is required during the eruptive stage of the disorder, which is seldom attended with danger. It is chiefly necessary to open the bowels, to confine the patient to a light vegetable diet, with cold acidulated aqueous drinks, and to maintain a cool temperature in the room, which should be moderately darkened. Where the skin is dry and hot, sponging it with cold water has been recommended and practised with benefit. The old practice of confining the patient in heated chambers, and covered with an overwhelming quantity of bed-clothes, is now justly abandoned: the free use of the lancet during the eruptive period of the disease is likewise laid aside, and its employment restricted to those cases in which any of the vital or important organs are threatened or attacked by inflammation. Cases in which the vital powers are low, to which the name *rubeola putrida* has been applied, of course will require an opposite mode of treatment, as the exhibition of bark, the mineral acids, and wine, together with a nutritious diet and a pure atmosphere: these, too, are the remedies which prove most serviceable in checking the diarrhœa, if injuriously protracted.

MEASURE. One number or magnitude is said to measure another, when the first is contained an exact number of times in the second. [Incommensurable; Proportion.]

MEASURES. [Standards; Weights and Measures.]

MECHANICAL POWERS is the name given to certain *simple machines* or *engines*, for these words are applied indifferently, either of which is occasionally used by itself in moving bodies or raising weights, or any of which are combined together in the formation of the complex constructions which are employed in manufactures and the arts. Frequently however, in investigations relating to statical equilibrium, the properties of the mechanical powers are introduced when no machine is contemplated; as when, at some part of a plane surface, the effect of a pressure at another part is determined by the ratio of the distances from a supposed point of support.

The several machines to which the name of mechanical powers is applied are the Lever, the Wheel and Axle, the Inclined Plane, the Wedge, the Screw, and the Funicular Machine.

The object proposed in every machine is to transmit a force from the point at which it is immediately applied to that at which some resistance is to be overcome or some operation to be performed; and, in the transmission, the intensity of the motive power is to be increased so that effects may be produced which could not be accomplished by that power alone. The increase of the power is obtained by causing part of the resistance which is to be overcome to rest on the machine or on the fixed points which serve for its support, so that only the part which remains is opposed to the motive force. Thus, if it be required to raise a heavy body to a certain height from the ground, no exertion of human or animal strength may be sufficient, if directly applied, to accomplish the end; but if a plane inclined to the horizon and extending from the object to the spot to which the latter is to be raised be formed, and the object can be placed on its foot, the force of gravity in the vertical direction being resolved into two forces, one of which is destroyed by the reaction of the plane, the other may be overcome by a motive power less in intensity than that which would be required if a direct application of force were made; in fact, the force which will suffice for the attainment of the end diminishes in proportion as the length of the plane is greater.

The manner of overcoming a resistance, which is specified in this example, will serve also to illustrate the well known fact that in every application of a mechanical contrivance to overcome a resistance, as much advantage is lost in respect of time or space as is gained in respect of power. For it is evident that, in order to raise the object vertically through a space equal to the height of the plane, it would be necessary to move it over a space equal to the length of the plane; that is, through a space which bears the same ratio to the vertical height as the weight of the object bears to the power required to move it up the plane.

An account of the applications of the mechanical powers in the construction of complex machines would involve descriptions of most of the engines by which human labour is abridged or dispensed with; some of the most typical of these are referred to under MACHINES, where the reader will also find a reference to works of authority on the subject.

In determining the efficacy of the mechanical powers it is evidently necessary to consider their parts as mathematical lines, to assume that the axles are without friction and cords without rigidity, so that a perfect equilibrium may subsist in the machine itself before the moving power is applied. The most simple lever, for example, of a physical kind, is a rod of wood or a bar of iron, the arms of which, on opposite sides of the fulcrum, are of unequal weights; and, in order to reduce such a lever to a state from which the exact relation between the opposing powers may be found, the weight of each arm must be computed, and being, in imagination, applied at the centre of gravity of the arm, the product of the weight multiplied by the distance of the centre of gravity from the fulcrum is to be added to the momentum of the weight actually applied to the same arm of the lever. The sums of these momenta, when the actual machine is in equilibrio, serve to determine the correct relation between the opposing powers. The conditions of equilibrium being determined, any excess of the motive power above that which enters into those conditions will evidently overcome the resistance, or produce motion in the machine.

MECHANICS is the science in which are investigated the actions of bodies on one another, either directly or by means of machinery.

These actions may be simple pressures without motion, as when one body being supported in any manner, another is placed upon it, either vertically or in some oblique position; or they may be such as are accompanied by motion, and these may arise either from the mutual attractions which all bodies in nature exercise upon each other, or from the collisions of bodies in motion with others which may be previously in motion or at rest.

The term is particularly applied to the mutual actions of solid bodies: the actions of fluids on solids form, in part, the subjects of HYDROSTATICS and HYDRODYNAMICS; but these, as well as *pneumatics*, are now frequently included under the general name *mechanics*. When bodies are at rest, and the actions are such as to maintain them in that state, the laws of the actions constitute that branch which is called STATICS; but when motion is concerned, the laws and phenomena constitute what is called DYNAMICS.

In all the branches of general mechanics the investigations are founded on experiment and are conducted by geometrical or algebraical processes: hence the science forms one of the departments of experimental philosophy, and also of mixed mathematics. This last denomination is applied to mechanics because in the latter are involved several qualities of bodies which do not enter into the researches of pure science, such as *mass* or *quantity of material*, *inertia*, *hardness*, *elasticity*, *time*, *space*, and *power* or *force*. The last-mentioned term is used to express the cause of the actions of bodies on one another; but we have no other conception of it than that it is productive of motion or of a tendency to motion, or that it arrests an actual motion or renders a tendency to motion ineffectual. When opposing forces act on a body so as to destroy each other's effects and keep the body unmoved, that body is said to be in a state of *equilibrium*; and this state is distinguished from that of mere rest, since the latter implies the absence of any cause by which the body might change its place.

The invention of simple machines for moving masses of any material which it might be beyond the unaided power of man to transport to a distance, must have taken place in the earliest ages of the world. Human ingenuity would readily suggest the application of a rod or bar of wood or iron, for the purpose of lifting a heavy body from the ground; and very little experience would suffice to show that rolling or pushing a block of stone up sloping ground was a much easier operation than that of raising it vertically by the strength of men's arms. Thus may have arisen the employment of the *lever* and *inclined plane*; and from these, subsequently, the *wheel and axle*, the *pulley*, the *wedge*, and the *screw*, were derived. The simple means here indicated would be sufficient, with the aid of manual labour, to build up the most massive cyclopean edifice; and even the vast materials which form the roofs of the Egyptian temples may have been raised to their places by means of inclined planes, formed of earth for the purpose, on the exterior of the walls, and afterwards removed.

The steps by which the art of constructing machines advanced have not been distinctly recorded; and the work of Vitruvius on architecture is almost the only source whence can be obtained an account of such as were in use in and before the time of that engineer (the age of Augustus or Vespasian). From the descriptions there given, it appears that among the mechanical powers then in use were the lever, the windlass, and the assemblage of pulleys. Vitruvius also mentions some ingenious contrivances for transporting heavy blocks of stone from the quarries, and a *forcing-pump*, the invention of which he ascribes to Ctesibius, for supplying the public fountains. He describes a complex machinery, consisting of *wheels* driving each other by *cogs* or *teeth*, which was applied to carriages or ships for the purpose of measuring the distances travelled or sailed; and he enters fully into the construction of *engines* for throwing darts or masses of stone. The *muscular strength* of men was then employed as a moving power in turning mills: *wheels* impelled *by river currents* acting on float-boards (*pennæ*) gave motion to machinery for grinding corn; and *wheels* turned *by men* walking on them were used for raising water by buckets or otherwise. Vitruvius generally mentions the names given by the Greeks to the machinery; and it might, without great risk of error, be presumed that much of that which he describes was in use among the latter people at, or even before, the time when the Parthenon was raised. There are no distinct intimations of the existence of *windmills* till the 12th century. The expansive force of *steam* can only be said to have become a moving power at the end of the 17th century, and then it was employed merely to raise water. Its general application to machinery must be dated from the year 1768.

In tracing the progress of discovery concerning the mathematical theory of mechanical action, we shall have little to notice till we come to the 16th century; for the ancients, who devoted themselves with so much ardour to the researches of pure science, almost entirely neglected the application of the latter to subjects which appeared to them to terminate in mere practical utility. It must be observed however that Aristotle, who left no department of nature untouched, has noticed, in his mechanical questions, the equilibrium of unequal weights on the unequal arms of a balanced lever, though he gives a very unphilosophical reason for the fact. But in his 'Physics' he states correctly that if two forces move with velocities reciprocally proportional to their intensities, they will exert equal efforts: this may apply to a well-known property of the lever, but it may have been meant to refer only to the effect of two unequal bodies moving with unequal velocities, and striking each other or a third body.

Sicily enjoys the honour of having given birth to the first philosopher who can properly be said to have been a theoretical mechanician: we allude to Archimedes, who died about 212 B.C., and in whose works there is direct evidence of an effort to determine the principle of equilibrium in machines. Commencing, in the treatise whose Latin title is 'De Æquiponderantibus,' with the axiom that two equal weights balance each other on a lever (of uniform dimensions), when at equal distances from the fulcrum, he supposes the weights to be divided into an equal number of equal parts, and that the parts are removed to equal distances from the point of support; observing then that the equilibrium still subsists, he proceeds, by the method of exhaustions, to show that it always will take place provided the bodies are inversely proportional to their distances from the fulcrum. Archimedes thence concludes that there must exist in every one body, considered as an assemblage of smaller bodies, a centre of force (that is, a centre of gravity) corresponding to the fulcrum in the former case; and he proceeds, by the analysis of that day, to investigate the seat of the centre of force in a triangle, a parabola, and a paraboloid.

This philosopher has obtained celebrity by the contrivances which he is said to have adopted for the defence of Syracuse. No precise account is given of the machinery which he employed to raise up and destroy the galleys of the enemy, and the effects are probably exaggerated. The vessels must have been close to the walls, and it is conceivable that, by hooks at the ends of chains which were suspended from levers on the ramparts, the rigging, or some parts of the turrets erected as usual on the decks, in order to enable the assailants to pass over the parapets, might be caught; then, the levers being raised by the force of men or otherwise, the vessels or the turrets would be easily overturned.

During about 1800 years, which elapsed between the time of Archimedes and that of Cardan, we have no other notices concerning the theory of mechanics (beyond those which occur in the writings of the former mathematician), than such as are contained in the 'Mathematical Collections' of Pappus, which amount merely to a statement that the ancients had reduced the theory of every machine to that of the lever, and an unsuccessful attempt to explain the cause of the equilibrium of a body on an inclined plane. It is remarkable moreover that both Cardan and, subsequently, the Marquis Ubaldi (the latter of whom published, in 1577, a treatise in which he explains at length the combinations of pulleys, and reduces their theory to that of the lever) should also have given erroneous solutions of the problem concerning that equilibrium. The discovery of the true theory of the inclined plane was however, about the same time, made by Stevinus, a native of Flanders. This mathematician and engineer supposed a chain of uniform dimensions to be placed on a doubly inclined plane, having a common summit and base, the chain being perfectly free to slide on the planes, and its ends hanging vertically to equal distances below the base; then, in order to prove that the chain would remain at rest, he shows that if any motion should take place, it might continue for ever; and this he concludes to be absurd. As the argument holds good when one of the two planes is in a vertical position, Stevinus infers that, when a body is in equilibrio upon a plane, the retaining power is to the weight as the height of the plane is to its length; and he further shows that if three forces act on any point, they hold the latter in equilibrio when they are proportional to the three sides of a triangle formed by lines drawn parallel to the directions of the forces. It should be remarked however that Stevinus demonstrates the law in that case only in which two of the forces are at right angles to each other. He died in 1635.

To Galileo we are indebted for the first reduction of mechanical propositions to purely mathematical formulæ. In order to demonstrate the equilibrium of a body on an inclined plane, he imagined the weight and the sustaining power to be applied to the ends of a bent lever whose arms were of equal length and perpendicular to the vertical and slant sides of the plane; then reducing the lever to a straight one, between the lines of direction of the weight and power, it was easy to prove that the forces in equilibrio on the plane were also in equilibrio on the lever, and were to one another as the length to the height of the plane.

But the most important discoveries of Galileo were those which relate to the times of descent, the spaces descended, and the velocities acquired when bodies fall by the action of gravity. He made observations on the motions of *pendulums*, and determined that the times of their vibrations are proportioned to the square roots of their lengths; he also gave theorems for the composition of two motions, when both are uniform, when both are accelerated, and when one is uniform and the other accelerated. Nor should we omit to state that he was the first to obtain expressions for the strength of materials in resisting the strains to which they are subject. It deserves notice moreover that Galileo, in opposing the arguments of one of his contemporaries concerning the law of the descent of bodies by gravity, makes a supposition that the spaces descended with the accelerated motion may be divided into equal parts, each so small that the motion during the time of describing it may, without sensible error, be considered as uniform; an hypothesis corresponding exactly to that which, agreeably to the principles of the modern analysis, is now employed in investigations concerning variable motions.

The theory of the *motions of fluids* was, apparently, first cultivated in Italy by Castelli, who wrote on the subject in 1638; and about the same time Torricelli, having discovered the existence of a space void of air in the upper part of a tube filled with mercury, its open end being immersed in a vessel of that fluid, was enabled to refute the ancient notion that nature *abhorred* a vacuum. The latter was subsequently led to the conclusion that the pressure of the atmosphere is the cause of the support of a column of mercury in a tube, and also of the ascent of water in pumps. Both of these writers were pupils of Galileo; and, soon after the time of this philosopher, the French mathematicians Descartes, Pascal, Fermat, and Roberval, prosecuted with ardour the *new science*, as that of mechanics was called. Among the fruits of their researches may be named the determination of the centres of oscillation and percussion in a body or system of bodies vibrating about a fixed axis. The impulse given by Galileo, being thus continued by a succession of men of talent both in Italy and France, caused the science to advance with an accelerated movement, and soon put it in a condition to embrace all the subjects of terrestrial physics.

The mechanics of that age was not however entirely emancipated from the trammels of a false philosophy; and the theory of Descartes, concerning the communication of motion when bodies strike each other, is remarkable on account of the metaphysical principle which it involves. In speaking of the *collision of bodies*, he gives as a reason why the same momentum should exist after as before the impact, that it depends on the divine immutability. God having created a certain quantity of motion to serve as the cause of all the operations of nature, that quantity, he conceives, can never be increased or diminished. Yet there is some reason to think that Descartes had better notions concerning the phenomena of collision, for he states correctly, in one of his letters, that the motion of a body when it strikes another which is at rest becomes divided between the two masses, and that the resulting velocity is diminished as the mass is augmented. The chief feature in the physics of Descartes is his supposition that the planets revolve about the sun in vortices of æther, the particles of which, having acquired a certain degree of centrifugal force, act on the planets and prevent them from falling together in the centre of the system. He supposed that the like vortices surround each planet: but the particles of æther, having less specific gravity than the bodies on the surface of the planet, the tendency of these bodies to that surface prevails over the force by which the æther causes them to recede from thence.

The laws of the collision of bodies, which had been in vain attempted by Descartes, were at length, and nearly at the same time, discovered by the English mathematicians Wallis and Sir Christopher Wren, and by Huyghens on the Continent. The first of these, in his treatise 'De Motu' (1670), divides bodies into such as are hard and such as are elastic, and he explains the phenomena attending the shock of bodies of both kinds. In that of hard bodies he adopts as an hypothesis that the body struck destroys as much motion in the striking body as the latter communicates to it; and in elastic bodies he considers the forces of compression and restitution to be proportional, in each, to the velocities before the shock. The name of Huyghens has become celebrated from the discovery of the properties of *cycloidal curves*, and the attempt to make the lower extremity of a clock-pendulum vibrate in an arc of that kind, in order that the times of vibration might be equal, whatever were the extent of the arc described. This attempt did not succeed; but, being led in the course of his inquiries to investigate the position of the centre of oscillation in a compound pendulum, Huyghens found that when several pendulous bodies descend by gravity and afterwards re-ascend by the acquired velocities, in whatever way they may act upon each other, their common centre of gravity cannot rise higher than the point from whence it descended. This proposition is considered as proved from the fact that, if it were otherwise, the centre of gravity might by mechanical means be made to rise continually higher, and thus perpetual motion might ensue: but this is impossible.

In 1687 Newton's great work concerning the mathematical principles of natural philosophy was first published, and from that time the mechanical sciences, which had hitherto been confined to the action of bodies on each other at the surface of the earth, were made to comprehend the laws of planetary motion. The 'Principia,' as the work is called, commences with the three well known axioms in philosophy, or *laws of motion*. Assuming then as an hypothesis, that all the bodies of the universe and all the particles of every body exert on each other mutual attractions; assuming also that the planetary bodies were originally put in motion by impulsive forces; the rotations of these bodies on their axes, their revolutions in their orbits, and all the perturbations by which their movements are varied, are explained by means of the elementary theorem for the composition and resolution of motions. The *oscillations of pendulums*, the *theory of projectiles*, the *movements of fluids*, and the *resistance* opposed by the latter to the motions of bodies immersed in them, are also in the same work investigated at length.

Contemporary with Wallis, Wren, and Newton in England, were, on the Continent, the celebrated Leibnitz and the two elder Bernoullis, all of whom contributed greatly to the advancement of mechanical science by their investigations concerning the laws of motion in terrestrial bodies; and to the rivalry as well as the talents of these great men we owe some of the most important discoveries in that branch of learning. At this time the *fluxional* or *differential calculus* was discovered, and had acquired an algorithm; and they who adopted its principles appear to have been anxious to show its superiority over the ancient geometrical analysis, by proposing to their opponents problems which could scarcely be solved by the latter method. With some such views Leibnitz proposed the determination of that curve along which a body descending would describe equal vertical spaces in equal times; James Bernoulli proposed to find the figure assumed by a flexible cord or chain when suspended at the extremities [CATENARY]; and John Bernoulli, to find the curve of swiftest descent. [CYCLOID.] Numerous other problems of the like nature were given out among the parties, and the solutions could not fail, if no other benefit arose, of carrying the new calculus to a considerable degree of perfection.

From the time of Newton mechanical science was, till lately, but little cultivated in this country; but on the Continent a succession of illustrious men continued to prosecute the investigation of subjects connected with it, and by the employment of analytical processes they rendered comparatively easy the application of its principles to the researches of *physical astronomy*.

The mathematicians who may be considered as the immediate successors of Newton were chiefly Euler, D'Alembert, and Clairaut; and in the works of the first of these are investigated all the circumstances attending the phenomena of *rectilinear* and *curvilinear motion* when a body in vacuo or in a resisting medium is subject to any forces whatever. But the most remarkable event in the history of the sciences, after the discoveries of the English philosopher, was the solution of the celebrated *problem of the three bodies*: or that whose object is to determine the motions of a body when attracted by and revolving about another, and continually disturbed by the attraction of a third. This was, at the same time (about 1752), and independently of each other, accomplished by the three learned men above named, and it now constitutes the basis of the whole planetary theory. The 'Mécanique Analytique' of La Grange, which was published in 1788, and the 'Mécanique Céleste' of La Place (1798 to 1825), contain the last accessions which the mechanical sciences have since received; and these sciences now comprehend the *laws of force* or *motion*, from the properties of the simple lever to the phenomena of the heavenly bodies.

It may have been seen above that the first general principle in mechanics is that of the *equilibrium of bodies* on a lever; and a knowledge of it may be ascribed to Archimedes. The extension of the principle to all the mechanical powers was long an unsolved problem, and the solution may be said to have been first made known to the world by the discovery of Stevinus, relating to the sustaining power on an inclined plane. A second general principle may be conceived to be that of the *composition of motions* or *forces*; and its discovery is to be ascribed to Galileo. Daniel Bernoulli (about 1726) was the first to demonstrate the rule of the *composition of forces* independently of motion; but the application of the principle as a means of obtaining general equations of equilibrium seems to have been first made in the 'Projet d'une Nouvelle Mécanique,' which was published by Varignon in 1687.

La Grange treats as a third principle in mechanics that of *virtual velocities*. By this is meant those which bodies in equilibrio would have at the first instant of their motion, in the event of the equilibrium being disturbed. Indications of this principle are found in the writings of Galileo, Wallis, and Descartes, but John Bernoulli is thought to have been the first who showed its utility in resolving statical problems. [VIRTUAL VELOCITIES.] A general method of solving mechanical propositions was discovered by D'Alembert, and it may be thus enunciated. If there be impressed on bodies motions which they are forced to change in consequence of their mutual actions, those motions may be considered as compounded of the motions which the bodies do really take, and of those which are destroyed. Whence it results that these last must be such that if they alone existed the bodies would be in equilibrio. In order to avoid the decompositions of motions which this principle requires, an equation is frequently made between the general analytical expression for a force and the expression for those forces which produce the observed motions. [FORCES, IMPRESSED.] The manner of estimating the value of a mechanical force is various; and a difference in the expression of the value gave rise to disputes which continued during nearly all the first half of the 18th century. [FORCE.]

Besides the principles above mentioned there occur in mechanical investigations several others, which it will be proper to state briefly in this place.

That which is called the *preservation of living forces* is a consequence of the discovery of Huyghens concerning the movement of the centre of gravity in a compound body. For the space described by that centre is expressed by the quotient arising from the sum of the products of the mass of each body into the distance it passes over, divided by the sum of the masses; and since the spaces descended by bodies when acted on by gravity are proportional to the squares of the velocities, it follows that the sum of the products of the mass of each body into the square of its velocity is constant, whether the bodies move jointly in any manner, or whether they descend freely through equal vertical spaces.

The preservation of the centre of gravity is a principle which contains the discovery of Newton, that the motion of the common centre of gravity of several bodies is not affected by the mutual attractions of the bodies. It was subsequently extended by D'Alembert, who shows that if the bodies are solicited by a constant accelerative force in directions either parallel to each other or tending to a fixed point, the centre of gravity must describe the same line as if the bodies were free.

The preservation of areas seems to have been discovered simultaneously by Euler, Daniel Bernoulli, and the Chevalier D'Arci, about 1750. According to the latter it is an extension of Newton's theorem that the *radii vectores* of revolving bodies describe equal areas in equal times, and it consists in this: that the sum of the products of the masses of revolving bodies into the areas described by their *radii vectores* about a fixed point is proportional to the time. Or the sum of the products of the masses into the velocities and into the perpendiculars let fall from the fixed point on the lines of direction of the motions is constant.

The principle of least action originally signified, that when bodies act on each other, the sum of the products of the masses into the velocities and spaces described is a minimum. But considered in the most general sense, agreeably to the extension given to it by La Grange, the principle consists in this: that in trajectories described by bodies subject to central forces, the integral of the velocity multiplied by the element of the orbit is always a maximum or a minimum.

A general outline of that part of mechanics which relates to the equilibrium of solid bodies is given under the word STATICS; and the details of the subjects may be seen under LEVER, WHEELS, &c. The part of mechanics which relates to bodies in motion appears under the words referred to in the article DYNAMICS.

MECHLOIC ACID. This acid was formed in 1835 by Couerbe, by passing chlorine gas over fused meconin. When purified by solution in potash, and precipitation by nitric acid, it exists in the state of colourless prismatic crystals, soluble in cold water, but more so in hot: alcohol and ether dissolve it sparingly. It melts at about 257°; at 376° it is volatilised; and by a strong heat it is decomposed. It contains

Hydrogen	4·07
Carbon	48·72
Oxygen	47·21
	100·00

MECONAMIC ACID. [MECONIC ACID.]

MECONATES. [MECONIC ACID.]

MECONIC ACID ($C_{14}HO_{11},3HO$). A substance found in opium, in which it exists in combination with the alkali morphia. It was first noticed by Seguin in 1804, and a few years after, more particularly described by Sertuerner, who named it *mecon* (μήκων), poppy. Meconate of lime is one of the results of a peculiar process for obtaining morphia from opium [OPIUM, ALKALOIDS OF]; this is put into ten times its weight of water at 200°, and hydrochloric acid is added until it is dissolved; the solution is to be filtered, and on cooling it deposits bi-meconate of lime in the state of light, scaly, or acicular crystals; these are again to be dissolved in hot and very dilute hydrochloric acid, which separates the remainder of the lime, and on cooling, the meconic acid crystallises in scales containing six equivalents of water of crystallisation. They are to be freed from colouring matter by subsequent treatment with purified animal charcoal, and recrystallisation. Meconic acid has then the following properties: it acts on litmus paper, and has a sour taste; it is soluble in four times its weight of water, and also in alcohol. The crystals do not alter by exposure to the air, but when heated to 212° they lose 21·5 per cent. of water, and become opaque. Although when heated even to near 250° the acid is not totally decomposed, yet the boiling solution gives out carbonic acid gas, and a brown substance is formed, which is comenic acid. When strongly heated, it is totally vaporised. When mixed with a solution of chloride of gold, and heated, it is decomposed, and metallic gold is precipitated. This acid possesses the characteristic property of forming a purplish-red coloured solution with the persalts of iron, and this is regarded as one of the best tests of its presence in the opium from which it is derived. It has been asserted that meconic acid is an antidote in cases of poisoning by corrosive sublimate, but this is not the case. It has no effect whatever.

Meconic acid is tribasic; one, two, or three atoms of the water in the above formula being replaceable by an equal number of equivalents of a base with formation of mono-, bi-, or tri-metallic salts, called *meconates*. Their properties are as follow:—*Meconate of Ammonia* crystallises in quadrilateral prisms, dissolves in one and a half times its weight of water, yields water when heated, and afterwards sublimes without decomposing. *Meconate of Potash* crystallises in tables and leaves, contains water of crystallisation, and is soluble in twice its weight of cold water. *Meconate of Soda* crystallises in fine needles, which contain much water of crystallisation, and are soluble in five times their weight of water. *Meconate of Lime* forms acicular crystals, which contain water of crystallisation, and are soluble in eight times their weight of water. When the acid is in excess the salt crystallises in prisms, and is difficultly soluble in water. *Meconate of Magnesia* when neutral is only slightly soluble, but the supersalt dissolves readily; it crystallises in flattened needles, which are brilliant and transparent, and have an acid and bitter taste. *Meconate of Baryta* is slightly soluble in water. *Meconate of Iron* is a colourless and very soluble salt, which becomes red by exposure to the air, and more rapidly by the addition of nitric acid. The *Permeconate of Iron* is also a soluble salt, and is of a fine red colour, destroyed by heat, by sulphurous acid, and protoxide of tin. *Meconate of Silver* explodes when heated. *Meconate of Oxide of Ethyl*, or *Meconic Ether*, or *Ethyl-meconic acid* ($C_4H_5O, 2HO, C_{14}HO_{11}$), separates out in acicular crystals on evaporating the liquid formed on passing dry hydrochloric acid gas through a solution of meconic acid in absolute alcohol. It forms very stable salts, called *Ethylmeconates*. The mother-liquor from the preparation of ethylmeconic acid contains crystalline *Diethylmeconic acid* ($2C_4H_5O$, HO, $C_{14}HO_{11}$).

Meconamic acid ($C_{14}H_5NO_{12}$) is precipitated when hydrochloric acid is added to *Meconamate of Ammonia*. The latter salt is produced by the reaction of ammonia and ethylmeconic acid.

Comenic acid, Metameconic acid, Parameconic acid ($C_{12}H_2O_8$,$2HO$). It has been mentioned above that when a solution of meconic acid is heated to ebullition, carbonic acid is evolved, and a brownish solution results; this consists of colouring matter and comenic acid. When a meconate, as of potash or lime, is boiled with hydrochloric acid, no colouring matter results, and yet comenic acid is formed.

This acid is soluble in sixteen times its weight of boiling water, and separates on cooling in hard anhydrous grains, which, like the meconic acid, redden the persalts of iron, but they differ from it in every other respect.

It is formed by the mere separation of carbonic acid, by subtracting two equivalents of which from meconic acid we obtain the acid in question:—

$$\underbrace{C_{14}HO_{11},\ 3HO}_{\text{Meconic acid.}} - 2CO_2 = \underbrace{C_{12}H_2O_8,\ 2HO}_{\text{Comenic acid.}}$$

Comenic acid is bibasic, forming neutral and acid *comenates*. *Ethylcomenic acid* is formed in a similar way to ethylmeconic acid. *Chlorocomenic acid* ($C_{12}H_3ClO_{10} + 3$ Aq.) is obtained by the action of chlorine on comenic acid. It crystallises in short prisms.

Comenamic acid ($C_{12}H_5NO_8$). Prepared by the action of heat upon a solution of comenate of ammonia. On adding a little hydrochloric acid, and cooling, it crystallises out in plates. The *comenamates* are monobasic.

Pyromeconic acid ($C_{10}H_4O_6$) is obtained by heating meconic acid, which yields about one-fifth of its weight. It is purified by pressure between folds of blotting paper, and crystallisation from solution in water. It is fusible between 248° and 257°, and then flows like oil; it is entirely soluble at a moderate temperature, and is more soluble in alcohol than in water. It turns the persalts of iron red, and its salts are generally soluble in water. It is formed by the separation of four equivalents of carbonic acid and one equivalent of water, from two equivalents of meconic acid. It is colourless, very sour, and mono-basic.

Bromine and iodine displace hydrogen, and form *Bromo-* and *Iodo-pyromeconic acids.*

MECONIN, or *Opianyl* ($C_{20}H_{10}O_8$), a neutral principle existing in opium, first noticed by Dablane, and more particularly examined by Couerbe. To obtain it, an infusion of opium, from which the morphine has been precipitated, is to be evaporated, and the crystallised matter obtained, after being pressed, is to be treated with boiling alcohol; the solution contains narceine and colouring matter, from which it is to be separated by subsequent operations. [OPIUM, ALKALOIDS OF.]

The properties of meconin are, that it is colourless, inodorous, is at first tasteless, but afterwards acrid; it is soluble in water, alcohol, and ether, and crystallises well from any of them; the crystalline form is a six-sided prism with dihedral summits; it fuses at 194°, and is volatilised at 310°, without undergoing any change of properties. It is soluble in about 265 parts of cold water, and 20 of boiling water. Sulphuric acid gives it a fine green or purplish colour. Chlorine renders it of a blood-red colour, forming *Mechloic acid.* It does not act either as an acid or an alkali. Nitric acid converts it into *Nitro-meconin* ($C_{20}H_9(NO_4)O_8$).

MEDALLET, a small medal.

MEDALLION, a medal of an extraordinary size. Medallions were never used as current coin; the term is more particularly applied to ancient Roman medals.

MEDALLION, in architecture, any circular or oval tablet on which heads, animals, flowers, or other objects, are represented in relief.

MEDALS. Numismatists have usually given the name of medals to those coins that have been struck or cast for particular purposes and on extraordinary occasions, in commemoration of victories, treaties, coronations, and similar important events, or in honour of remarkable persons, in distinction to those which have been issued and generally circulated as money.

The words *medaglia* and *medaglione* first occur in Italian writers, from whom the English and French have evidently taken their *medal* and *medaille.* The derivation seems to be from the Greek *μέταλλον* (metal), of which medals are always made.

A reference to medals, in connection with numismatics, has been made in the article on coins [COIN], to which a few observations must now be added respecting them independently of their relation to the general subject. Owing to the earlier writers on ancient coins considering them as medals, and not coins, the term knowledge of medals was applied to the study of numismatics. The Greeks struck no medals; but certain large coins of Syracuse, weighing from 668 to 680 grains of silver, dekadrachms, or pieces of 10 drachms, have been called erroneously by some numismatists *medallions.* They were, however, destined for circulation, like the 20 shilling silver coin of Charles I. in England, and the 100 zecchini gold of Ludovico Manin, doge of Venice, 1789-97. The first ancient medals, in the proper sense of the word, are the Roman brass *medallions* [NUMISMATICS], with which may be classed the brass pieces called *contorniati, spintriæ,* &c. Gold and silver coins of unusual size and weight are also called medallions, and by some supposed to have been issued for commemorative purposes.

Among the peculiarities which distinguish modern from ancient medals, may be mentioned the introduction of portraits of illustrious characters who were not of princely or regal houses. It is remarkable that while busts are found of many celebrated poets, historians, and philosophers of antiquity, their portraits seldom occur on medals. When, after the long interval of darkness in which literature and art were enveloped, from the decline of the Roman empire to the 7th or 8th century, taste began again to appear, and, with the other arts, die-engraving revived, it was employed in transmitting to posterity the portraits of eminent individuals.

The first medals were the productions of painters and sculptors, and were made of lead or bronze, and cast in moulds of clay or fine sand taken from models of wax. The art was subsequently taken up by goldsmiths, and medals were made in repoussé work, or in chasing in the precious metals, or in bronze, a style of work which Carradosso and Cellini chiefly produced. At the beginning of the 16th century, in Germany, medals were made in boxwood or soapstone from which moulds were made: and the medals cast and chased by Albert Durer and other artists. At the beginning of the 17th century Camelio began to cut steel dies, a master mould, or model of raised steel, was made, and soft iron dies stamped from it. Cellini had previously used dies for small medals. About A.D. 1583 small enamelled medals were made by jewellers for ornamental purposes.

The earliest examples of modern medals and medallions seem to be of the 15th century, though there is one remarkable exception to this in a medal of David II., king of Scotland. It is of gold, and was probably executed during that prince's captivity in England, some time between the years 1330 and 1370. Another medal of A.D. 1371, of the Lord of Schornverst is also known. From the 15th century there is a succession of medals in most European countries. A gold medal of the council of Florence, dated 1439, is one of the earliest. A still earlier one, if the date 1415 is correct, is of John Huss; but some doubts have been entertained of its authenticity. Vittore Pisano, a painter of Verona, is celebrated as the restorer of the art at that period; but the medal alluded to of David of Scotland seems to prove that it was practised before his time. Pisano's medals are very large, and are all cast. They are usually inscribed "Opus Pisani Pictoris." It is curious that he should always refer to his being a painter, while exercising a totally distinct branch of art. Another painter, Boldu, in 1457 made a medal of the poet Mesararo.

The Papal medals are among the finest of a continued series. They commence properly with Paul II., who began to reign in 1464, those of pontiffs who lived prior to that date having been added to the collection by his successors. Till the age of Julius II. they were cast in moulds, and not struck. Some of the medals of a later period are valuable examples of the art, in which great improvements took place under Alexander VI. His successors, Julius II., Leo X., and Clement VII., had many of their medals designed by Raffaelle and Giulio Romano, while Benvenuto Cellini and other distinguished artists were employed to engrave them. The medals of Julius III., in 1550, and of Gregory XIII., in 1571, were made by Covinio and Bassiano. Cormani, who engraved in 1644 a medal of Innocent X., having on the reverse Olympia Maidalchina, was imprisoned. Parmigiano engraved a medal of Gregory XIII., on the Restoration of the Calendar. Many of the Cinque-Cento medals are chased, as well as cast or struck. A German family, named Ermerani, or Hamerani, of eminence as medal engravers, settled in Italy about the middle of the 17th century, and executed many of the papal medals. This talent was not, it appears, confined to the men of this family; Venuti says each of the daughters also produced a fine medal. In later times Girometti and Cerbara are renowned.

The German medals commence in 1453, and are very numerous; the Emperor Maximilian I. and Rudolph II. employed Italian artists, but the German artists of Augsburg and Nuremberg acquired great celebrity. The Sicilian medals appear as early as 1501. The first modern satirical medal is of that time, and was published by Frederick II. against his adversary Ferdinand, king of Spain. It bears on one side the head of Ferdinand, with the inscription FERDINANDVS R. AR. VETUS VULPES ORBIS; on the reverse, a wolf carrying off a sheep, with JUGUM MEUM SUAVE EST ET ONUS MEUM LEVE. Many others might be mentioned of this description. The employment of medals for the conveyance of satire is not confined to the moderns. They are the precursors of the modern caricatures.

In Russia the taste for medals commenced with Peter the Great, and Maria Feodorowna the wife of Paul I., and Count Feodor Tolstoy, in the beginning of this century, engraved medals of considerable merit.

The Spanish medals begin in 1503. The earliest of Venice appear in 1509; and those of Denmark in 1474. The first Dutch medals seem to be of 1566, and they are remarkable for the elaborate views, maps, and plans that are engraved on many of them. It has been observed among the distinctions of ancient and modern medals, that in the former, when buildings are represented, the simple elevations only are given, while in the latter perspective views are exhibited. The Dutch indulged very freely in the satirical vein, and for which they eventually paid very dearly, as it contributed, in no small degree, to bring on them the whole hostile power of France under Louis XIV., who is said to have been highly exasperated at the publication of a medal in which Van Heubingen, the Dutch ambassador, was represented as Joshua (his name) arresting the progress of the sun, under which type the flatterers of Louis designated that monarch. Mueller, Pool, and Abeele were chiefly renowned.

The French medals commence with Louis XI., and reached high perfection in the reign of Francis I., who employed Cellini. The popularity of Louis XIV. gave an impulse to the art, and we find his entire life illustrated (with more respect, however, to the national glory and the prince's vanity than to historical truth) by medals; some of them are well designed and finely executed. The best engravers of these medals were Dupré, Varin, and Duvivier. The medallic history of Napoleon I. deserves notice in the series of medals of France. It is of great extent, and is, for the most part, honourable to French art. These medals, executed by Andrieu, Jeuffroi, Droz, and Manfredini, exhibit great classical taste and feeling, and contain a record of the events of the first empire. The reverses are generally allegorical. Many of them were executed from the designs of the celebrated Denon, and the painter David. One, struck in anticipation of the taking of London, is remarkably rare. In recent times Barrè made fine medals for Louis Philippe.

The series of English coins and medals is one of the most perfect. The first medal is of 1480. It is of a large size, and is executed in the early Italian manner. On one side is a portrait of Sir John Kendal, general of cavalry of the order of Rhodes, with IO. KENDAL. RHODI. TURCOUPELLARIUS; on the reverse, the arms of Kendal, with the inscription TEMPORE OBSIDIONIS TURCORUM. MCCCCLXXX. It is believed to be of foreign, probably Italian, workmanship. The next English medal is of the time of Henry VIII. It is of gold, and bears the king's portrait on one side, with an inscription on the reverse. The first coronation medal appears in the reign of Edward VI. The medals of Queen Mary are numerous, and very interesting from the devices they bear. There are many fine and beautiful medals of Elizabeth. The Scotch coronation medal of Charles I. is of gold, and was struck at Edinburgh. Briot was the best artist of this reign. It is remarkable as being the first struck in Britain with a legend on the edge. Specimens of this medal in gold are very scarce. The medals of the Commonwealth and of Charles II. are by Simon, and by the Roettiers, Dutch engravers, who were succeeded by Croker, engraver in the reign of Anne. Those of Queen Anne are interesting from their being charged with the achievements of the great Duke of Marlborough. Soon after this a Genevese artist, of the name of Dassier, was employed upon the medals of the kings of England, and executed many portraits of royal and other illustrious characters. Natter, the celebrated gem engraver, made medals in the reign of George III. In recent times many admirable medals have been engraved by the Wyons, and Pistrucci, a celebrated gem engraver.

The only Oriental nation that appears to have issued medals at an early period is the Chinese, military medals having been used during the Han dynasty, A.D. 10, and being kept up till the present day. Few or no medals exist of Indian states, except the supposed gold medal of Jehanghir, A.D. 1611, representing that monarch holding a flower on one side, and the constellation Leo on the other, which is probably a coin; and the large piece of Shah Jehan, made at Delhi, A.D. 1617.

The study of medals is, in its class, of great importance. It is indispensable to the historian and the antiquary, and hardly less valuable to the man of taste. To the former, medals often afford information that cannot be obtained by other means, in the inscriptions, legends, and allegories with which they are charged; while to the artist and connoisseur many of them offer not only exceedingly beautiful examples of art, but, if their authenticity can be depended on, a series of medals of any nation is one of the best authorities that can be consulted for the state of the arts of design of any particular period.

Modern medals differ in their art and treatment greatly from the Roman medallions, the last representing a few political and religious ideas treated in an allegorical manner, while medals represent the busts of distinguished persons, or of allegorical personages, subjects treated in an allegorical manner derived from the antique, or various events represented in a pictorial rather than a glyphic manner—sieges, buildings, edifices, instruments, machines, and other objects of nature, art, or civilisation. Amongst the moderns, medals take the place of honorary rewards for merit, either in intellectual acquirements, military, civil, or social services, and have replaced the crowns, trappings, and torques presented by Greece and Rome to illustrious citizens. As early as Henry IV. of France, and during the 17th century, it became the practice for monarchs to present medals, having their portraits, attached to gold chains, to warriors, statesmen, and men of letters. Such chains and medals were presented by the Parliament in the days of the Commonwealth to Blake and his captains, and Elizabeth conferred similar rewards on those who aided to overthrow the Armada. While, too, the medallions convey little information beyond that imparted by coins, the range of subjects in modern medals will convey to posterity representations of buildings, inventions, and events probably long after all other knowledge of them has perished, and will prove invaluable aids to the future students of chronology, history, and the arts.

It would be an almost endless task to enumerate the works that have been written on medals. The principal works on modern medals are those of Menetrier, Fleuremont, Godennesche, Lenormant, and Millingen, for those of France; Van Loon has described those of Belgium and the Low Countries; Hedlinger and Brenner those of Sweden, Denmark, and Russia; Evelyn and Pinkerton those of England; Mazzuchelli, the Italian medals of the Cinque-Cento period; Klotz, the satyrical pieces; and Koehne, some of Germany. See Bolzenthal, H., 'Skizzen zur Kunstgeschichte der Medaillen-Arbeit,' 8vo, Berlin, 1840.

MEDICINE. The earliest records of the practice of medicine are extremely obscure. Among the Jews it appears to have been entirely confined to the priests, and the whole art seems to have consisted in the prevention of contagion by isolation and cleanliness, and the administration of a few uncertain remedies. The Egyptians, according to the account of Herodotus, must have made some little progress; purging medicines and emetics were well known to them and much used; and such was the subdivision of labour, that there were physicians for every separate complaint, some for the eyes, others for the head, others for the teeth, others for the abdominal parts, and others for diseases which did not manifest themselves by outward visible symptoms. (Herod., ii. 84.) It appears however that in the time of Darius the son of Hystaspes, the Greeks possessed at least more skill than the Egyptians. (Herod., iii. 129.) The Greeks probably derived their knowledge of medicine, with that of many other arts, from Egypt, whence Chiron, the Centaur of their fables, is said to have first introduced it among them. His pupil Æsculapius [ÆSCULAPIUS, in BIOG. DIV.] so much improved the art, that he was deified; and Machaon and Podalirius, his sons, accompanied the Grecian army to the siege of Troy. From circumstances mentioned in the 'Iliad,' it would appear that their practice was almost entirely confined to the treatment of wounds, and that charms and incantations formed a considerable portion of the means which they employed. The descendants of Æsculapius were for many years the chief practitioners of medicine: they were called Asclepiadæ, and were the priests of the temples erected in honour of their progenitor, to which the sick were accustomed to resort for advice and the application of remedies.

In the 6th century before the Christian era, medicine, with other sciences, began to be more philosophically studied in Greece, and among the first of those who devoted much of their time to the investigation of the structure and functions of the animal body was Pythagoras. His pupils Democritus and Heraclitus appear also to have added considerably to the knowledge both of anatomy and of practical medicine, and their contemporary Herodicus first introduced the practice of gymnastic exercises, which afterwards formed so large a part of medical treatment. [GYMNASTICS.] But the most remarkable man in the history of medicine in Greece was Hippocrates, one of the Asclepiadæ, who was born at Cos (where one of the chief temples was erected), B.C. 460, and was the pupil of Heraclitus and Herodicus. [HIPPOCRATES, in BIOG. DIV.] The improvements which he made in medicine (and many of which are detailed in the article referred to) were so considerable, that for many centuries his successors appear to have been content to follow him in reverential imitation. His sons, Thessalus and Draco, and his son-in-law Polybius, were the most renowned of his descendants, and they are generally regarded as the founders of the medical sect or school which was called the Hippocratean or Dogmatic sect.

The establishment of the Alexandrian school of philosophy forms the next most important epoch. The science of medicine was assiduously cultivated, and the human body was first dissected in Alexandria by Erasistratus and Herophilus. [HEROPHILUS, in BIOG. DIV.] The former was the pupil of Chrysippus, a violent opponent of the Hippocratic school, and a bold innovator in medicine, with whom probably originated the schism in consequence of which, for some centuries, every physician ranged himself in one of two sects, the Dogmatists and the Empirics. The Dogmatists held that disease could not be securely treated, except on the foundation of a knowledge of the healthy structure and actions of the body, and of the influence of remedies and the effects of disease upon it; while the Empirics maintained that such knowledge was not only unnecessary, but unattainable, and that simple experience should be the only guide to practice. The progress of the science was greatly arrested by the observation of facts being neglected in the ardour with which each party argued its own cause, and the dispute only seemed to cease with the introduction of a new sect.

During the early periods of the Roman empire medicine seems to have been little cultivated, and, according to Pliny (xxix. 1), Rome was for 600 years without professed physicians, though not entirely without medical knowledge. The first individual of any eminence who practised medicine in Rome was Asclepiades of Bithynia [ASCLEPIADES, in BIOG. DIV.], who lived in the century before the commencement of the Christian era; but he does not appear to have advanced the knowledge of the science. He was succeeded by his pupil Themison, the founder of a sect called Methodics, who held doctrines nearly intermediate between those of the Dogmatists and of the Empirics. A large majority of succeeding physicians attached themselves to this sect, and among them were Soranus and Aurelianus, whose writings are the principal that remain of this period.

About two centuries later the Methodics were divided into numerous sects, as the doctrines of particular physicians became more generally received. The chief of these sects were the Pneumatics and the Eclectics. The former are represented by their most eminent writer, Aretæus [ARETÆUS, in BIOG. DIV.], who lived in the reign of Vespasian, and the chief points of their doctrines are detailed in his life. Of the Eclectics, the most celebrated was Archigenes, of Apamea, who practised at Rome in the time of Trajan. But the most remarkable writer of this age was Celsus, in whose work, 'De Medicinâ,' the progress and condition of medicine previously to and during his life are amply detailed. [CELSUS, in BIOG. DIV.] He was the first native of Rome who is known to have studied medicine, and the only one who did so with success. In his time medicine, which, as a science, might be said to have had its origin with Hippocrates, had made considerable progress; the several sects of its professors differed rather in their pretensions than in any important point of knowledge; the philosophical learning, which some sought and others despised, was almost entirely hypothetical, and had relation only to the doctrines of the mutual actions of imaginary atoms, elements, and spirits, but all had been alike engaged in the study of practical medicine, and their accumulated experience had by this time formed a very considerable amount of useful knowledge.

The individual whose history forms the next chief epoch in the history of medicine is Galen; but it will be unnecessary to repeat what has already been said of his doctrines and practice. [GALEN, in BIOG. DIV.] For a long time after his death physicians were chiefly occupied in commenting on his works, and imitating, as closely as they could, his practice. His writings were regarded as ultimate authority, and everything that seemed opposed to them was at once rejected. From the time of Galen to the 7th century the only names of any repute (and theirs is but small) are Sextus Empiricus, Oribasius, Ætius, Alexander Trallianus, and Paulus of Ægina; and after the death of the last of these, no medical work of the least merit was published in the Greek language.

From the 7th to the 12th century the only nation in which medicine made any progress, or was even prevented from retrograding, was the Arabian. It appears that on the conquest of Alexandria some books were saved from the burning of its magnificent library, and that among them were the writings of Hippocrates and Galen. The latter were soon translated into Arabic and diligently studied; and all the earliest Arabian works on medicine, as those of Ahrun in the 8th, and Serapion in the 9th century, are little more than transcripts of those of Galen. One of the most illustrious of the Arabian school was Rhazes [RHAZES, in BIOG. DIV.], who was born in the 9th century, and whose works contain many original observations, of which the most remarkable relate to some important diseases, unknown to, or at least not described by former writers, as smallpox and measles. In those parts of his writings which relate to pharmacy Rhazes describes some of the earliest of what are called chemical remedies, which are doubtless suggested by the recent origin of the systematic practice of chemistry among his countrymen. After Rhazes was Ali-Abbas, and after him Avicenna [AVICENNA, in BIOG. DIV.], who attained the highest repute of all. He was born in 980, and has left voluminous writings, which however appear to show that his fame is deserved only when he is placed in comparison with his contemporaries. Neither Avicenna nor the later writers, Mesue and Albucasis, contributed anything of importance to the progress of medicine. Avenzoar and Averroes were disciples of the Arabian school, and, though natives of Spain, wrote in the Arabic language. The former was the preceptor of the latter, and lived in the 11th century, and his works are among the few that exhibit even slight departures from the doctrines of Galen. The circumstances which chiefly mark the period of the Arabian school of medicine are, the more correct description of several diseases, the first records of some new and important ones, and the introduction of several valuable remedies, both from the vegetable productions of the tropical and oriental countries, and from the chemical processes which were then first brought into general use. But the physicians adhered too carefully to the doctrines of Galen to make much progress in their science; and anatomy, physiology, and pathology appear to have been almost entirely neglected.

From the decline of the Arabian school in the 12th century to the beginning of the 15th, the history of medicine presents few circumstances of interest. The dissection of the human body was first publicly practised by Mondini at Bologna, about the year 1315; and at about the same time lived Gilbert, the first English writer on medicine who acquired any repute. Between the 12th and 15th centuries several of the most important universities were founded, with a school of medicine attached to each: that of Salerno was established in the 12th century, that of Montpelier in the 13th, those of Bologna, Vienna, and Paris in the 14th, and in the 15th those of Rome, Padua, Pavia, and several other cities in Italy. By means of these, and by the impetus which, with all other sciences, it received from the invention of printing, medicine again commenced a forward course. In this country it derived the greatest advantages from Linacre [LINACRE, in BIOG. DIV.] and the establishment of the College of Physicians, to whose members, in succeeding years, several of the most brilliant discoveries are due.

In the 15th century the sect of chemical physicians arose, and their doctrines, under the bold advocacy of Paracelsus, who publicly burnt the writings of Galen, obtained considerable credit and numerous supporters. Their main assertion was that the operations of the living body are entirely governed by the same chemical laws as obtain in inorganic matter; and the works of all the writers of the 15th century are filled with arguments in support either of this doctrine or of the more ancient tenets of Galen. The Galenists were of course the more learned party, who were well versed in the ancient books; while the chemists were chiefly those who were more practically skilled in the arts of that newly discovered science. Neither party can be said to have much advanced the knowledge of medicine; but in the middle of the 16th century the most important improvement commenced in the diligent and accurate study of anatomy by Vesalius [VESALIUS, in BIOG. DIV.], who, disregarding the general obloquy which he incurred, carefully studied the structure of the most important parts of the human body.

From the time of Vesalius, the study of anatomy was diligently pursued, and in the early part of the 17th century was rewarded by several of the most interesting and important discoveries; as that of the circulation by Harvey [HARVEY, in BIOG. DIV.], of the absorbents by Asellius, of the process of respiration by Malpighi [MALPIGHI, in BIOG. DIV.], and numerous others. Among the most celebrated men of the 17th century, may be enumerated Glisson, Bartholin, Rudbeck, Fabricius, Hooke, Sylvius, Willis, Riolanus, Fallopius, and Bellini. All of them were employed in the diligent pursuit of anatomical and physiological knowledge; and, somewhat later, Sydenham [SYDENHAM, in BIOG. DIV.] again introduced a truly Hippocratic mode of observation of the phenomena of disease in its symptoms, causes, and effects, and in the influence of remedies upon it. By the combined efforts of the anatomists and the practical physicians, medicine in this century made the most remarkable progress, although it was in some measure checked by the attempted application of the laws of mechanics (then, from the discoveries of Newton and others, the dominant science) to the explanation of all the phenomena of the living body. The iatro-mathematicians, as those who supported this theory were called, were long engaged with the chemists, who had already conquered the Galenists; and to these rival sects was then added that of the Vitalists, founded by Van Helmont [HELMONT, VAN, in BIOG. DIV.], which at last obtained complete ascendancy over both. The Vitalists held that there is in the living body a principle (upon which different members of the sect conferred different hypothetical appellations) which presides over and directs all the processes of the living body, and is directly opposed to the influence of chemical and mechanical agents. Stahl, Hoffmann, and Boerhaave were of this school, though each considerably modified the opinions of its founder.

Among the pupils of Boerhaave were Van Swieten and Haller. [HALLER, in BIOG. DIV.] The former adopted the hypothetical spirit of the school too closely to add much of real value to medical science; but the latter may be fairly considered to have done more for it than any other single individual. Before the time of Haller, the cases of Harvey, Glisson, Malpighi, and others who devoted themselves to the simple observation of facts and the evident deductions from them, were exceptional; but since his time, the exceptions have rather been those who, with a comparative neglect of observation, have endeavoured only to find or support some theory by which all the phenomena they met with might seem explained. Haller's contemporary Cullen [CULLEN, in BIOG. DIV.], though he yielded much more to theory, was of eminent service in the study of practical medicine; and his opponent Brown is acknowledged to have introduced many useful lessons in the same branch of the study.

With the gradual oblivion of the hypotheses of both Cullen and Brown, the theoretical study of medicine may be considered to have entirely ceased, and in the present day we may certainly be said to be without any general medical theory. From the time of Haller, medicine has acquired more and more nearly the character of a science of simple observation and the patient investigation of facts. Its history would therefore consist of little more than a recital of successive discoveries, each perhaps small when compared with the vast amount of knowledge still unexplored, yet altogether so numerous that even a sketch of them could not be here introduced. The reader must therefore be referred to the several articles on the different branches of medicine and its collateral sciences, and to the lives [BIOG. DIV.] of those who have been most conspicuous for their discoveries.

MEDITATIO FUGAE WARRANT, in the law of Scotland, is a writ by which a debtor, supposed to be about to make his escape from the country, is arrested and kept in custody until he pay the debt, or find security to pay it if he shall be judicially found liable to do so. It may be granted by any judge having jurisdiction in questions of debtor and creditor, as by a sheriff, or the magistrates of a burgh. When granted by a sheriff, it has the advantage that it may be executed in any part of Scotland, whether without or within the jurisdiction of the sheriff who grants it.

MEDULLIN. A name given by John to the pith of the elder, after it has been treated with water and with alcohol. It is insoluble in water, alcohol, ether, oils, or dilute alkaline solutions; concentrated sulphuric acid carbonises it; nitric acid converts it into oxalic acid.

It is a modification of cellulose. [CELLULOSE.]

MEERSCHAUM means in German *sea foam;* and the equivalent French name of *écume de mer* is applied to the same substance. It is a silicated magnesian mineral, found in Greece, Turkey, and a few other countries. It is used by the Tartars for washing linen, somewhat in the same manner as pearl ash or fullers' earth. The mineral is principally used however as a material for tobacco pipes, which, when made, are soaked in melted tallow, then in white wax, and finally polished with shave-grass. If genuine, a meerschaum pipe acquires a beautiful brown colour after being smoked for some time, the oil of the tobacco being absorbed by the clay; and this is a point to which connoisseurs in smoking attach much importance.

Dr. E. D. Clarke gives some interesting details on this subject. In the Crimea the meerschaum clay is called *keff-kil*, and forms a stratum about two feet thick, beneath a much thicker stratum of marl. "The first rude form is given to the pipes upon the spot where the mineral is found; here they are pressed within a mould, and laid in the sun to harden; afterwards they are baked in an oven, boiled in milk, and rubbed with soft leather. In this state they go to Constantinople, where there is a peculiar bazaar or khan for the sale of them; they are then bought up by merchants, and sent by caravans to Pesth in Hungary. Still the form of the pipe is large and rude. At Pesth a manufacturer begins to fit them for the German markets. They are there soaked for twenty-four hours in water, and then turned in a lathe. In this process many of them, proving porous, are rejected. Sometimes only two or three out of ten are deemed worthy of further labour. From Pesth they are conveyed to Vienna, and frequently mounted in silver. After this they are carried to the fairs of Leipsic, Frankfort, Mannheim, and other towns upon the Rhine, where the best sell from three to five and even seven pounds sterling. When the oil of tobacco, after long smoking, has given them a fine porcelain yellow, or which is more prized, a dark tortoise-shell hue, they have been known to sell for forty or fifty pounds of our money.

Since Dr. Clarke wrote, a change has taken place in the manufacturing arrangements. Rough Turkish bowls still occasionally come to market; but the meerschaum is mostly sent to Germany in the form of irregular blocks, with obtuse angles and edges: requiring careful manipulation with the aid of water to remove irregularities and faulty portions. Many specimens contain a harder sort of meerschaum, which the Germans call *kreidemassen*, and which is a cause of much difficulty in the subsequent carving. In order to economise the shreds and parings produced during the manufacture, they are brought to a fine powder, boiled in water, and moulded into blocks with or without the addition of clay. Each of these blocks is afterwards moulded and carved into a bowl. These bowls are distinguished from real meerschaum by a greater specific gravity; but in other respects they are not easily distinguished.

Some large and fine specimens of meerschaum are carved so elaborately into pipe-bowls, as to command two or three hundred guineas each.

MEGARIAN SCHOOL. After the death of Socrates the majority of his disciples retired to Megara ('Diog. Laert.' ii. 106, iii. 6), where Euclid, one of the oldest of them, resided. [Euclid of Megara, in Biog. Div.] A few of these disciples remained at Megara with Euclid, who was looked upon as the founder of a school of philosophy which is usually known by the name of Megarian. In this school the Eleatic philosophy was taught, modified to some extent by the doctrines of Socrates. The Megarian philosophers maintained that the Supreme Good was always the same and unchangeable. They were distinguished in later times by their dialectic subtlety, and by the invention and solution of sophisms; on which account they were called Eristici (*ἐριστικοί*) and Dialectici (*διαλεκτικοί*). ('Diog. Laert.,' ii. 106.)

The most celebrated of the successors of Euclid were, Eubulides of Miletus, who opposed certain opinions of Aristotle; Diodorus, surnamed Cronos, who was originally of Iassus in Caria, a pupil of Eubulides, and who lived in Egypt in the time of Ptolemy Soter; and Stilpo, who was originally of Megara, but afterwards resided at the court of Ptolemy Soter.

MELAIN, a name which has been given to the colouring matter of the ink of the cuttle-fish. It is obtained pure by evaporating the ink to dryness and boiling the residue successively in water, alcohol, hydrochloric acid, more water, and a little carbonate of ammonia. Dr. Prout found 100 parts of the dry residue of the ink of the cuttle-fish to be composed of—Melain, 78·; carbonate of lime, 10·40; carbonate of magnesia, 7·; substance analogous to mucus, 0·84: various salts, 2·16.

This substance has not been further investigated, and its existence as a distinct body must be regarded as problematical.

MELALEUCA CAJEPUTI (Roxb.), the *Melaleuca Minor* (Smith), a native of the Molucca islands, but cultivated in North-West India, yields the oil termed cajeput. It is obtained by distillation of the leaves and branches, which are collected the night before they are subjected to this process. It is very limpid, pellucid, and of a light or yellowish green colour. Specific gravity, 0·927; it boils at 343° Fahr. It is possessed of a penetrating odour; the taste is acridly aromatic, leaving a sense of coldness in the mouth. Its chemical composition is, carbon 78·12, hydrogen 11·49, oxygen 10·38. It seems to consist of two distinct oils: one transparent as water, of specific gravity 0·897; the second dark green, of specific gravity 0·920. Unrectified oil reddens litmus paper, but rectified does not. It does not detonate with iodine, nor does it form an artificial camphor with hydrochloric acid gas, but has its colour much changed by that gas. It never deposits a stearopten. Some samples of cajeput oil contain copper, which may be detected by shaking the bottle with a solution of ferrocyanide of potassium; an artificial oil is also sometimes vended, but it is not difficult to detect the fraud. It is an aromatic stimulant.

MELAM ($C_6H_6N_6 = 3\ NCyH_2$), *Poliene.* A compound substance discovered by Liebig. It may be prepared by simply heating sulphocyanide of ammonium, or a mixture of sulphocyanide of potassium and sal ammoniac; by their action there are produced three volatile products and a solid substance; the three first are ammonia, sulphuretted hydrogen, and sulphide of carbon; the solid body is a mixture of melam and chloride of potassium, which are easily separated by washing with water.

The properties of melam are:—It is a non-crystalline powder, of a grayish white colour, and is insoluble in water, alcohol, or ether; a boiling solution of potash dissolves and eventually decomposes it; boiling and concentrated nitric and sulphuric acid dissolve it, and the solutions, when treated with alcohol, produce a precipitate of ammelide; when the acid solutions are boiled for some hours, the melam is converted into ammonia and cyanuric acid.

By the action of heat melam is converted into ammonia and mellon: hydrochloric and dilute nitric acid convert it into ammeline and melamine: and when fused with hydrate of potash, ammoniacal gas and cyanate of potash are produced.

It is isomeric with cyanamide.

MELAMINE ($C_6H_6N_6 = 3\ NCyH_2$). One of the simplest processes for preparing melamine is to boil melam until it dissolves in a moderately strong solution of potash; when the liquor has been concentrated and cools, melamine separates in crystals, and by recrystallisation it is obtained in a pure state.

Its properties are:—It crystallises in rhombic octohedrons, which are transparent and colourless, or only slightly yellow. It is very slightly soluble in cold water, but more so in boiling water. It is insoluble in alcohol or in ether, and is unalterable in the air; the aqueous solution has a bitter taste, and has no action on vegetable colours. When dry melamine is heated, it fuses, and sublimes almost entirely without decomposing; but a small portion is converted into mellon and ammonia.

Concentrated sulphuric acid and nitric acid decompose it, when heated, into ammonia and ammelide or ammeline. When fused with hydrate of potash, there are produced ammonia and cyanate of potash.

It combines with dilute acids to form salts, all of which have an acid reaction except the double basic salts. The nitrate, phosphate, and oxalate are less soluble than the melamine itself; but the acetate and formiate are very soluble. Melamine precipitates a part of magnesia from solution, and forms a double salt with that which remains dissolved.

It is isomeric with cyanamide.

MELAMPYRIN, is a crystallised non-azotised substance obtained from the cow-wheat, *Melampyrum nemorosum*. It is a tasteless neutral principle.

MELANIC ACID ($C_{20}H_8O_{10}$). An organic acid resembling lampblack in appearance, formed from hydride of salicyl. It is insoluble in water, but very soluble in alcohol, ether, and alkaline solutions.

MELANILINE ($C_{26}H_{13}N_3$). A cyanogen derivative of aniline.

MELANIN. The black pigment of the eye has received this name. It is insoluble in water, alcohol, and ether; but dissolves in caustic potash with disengagement of ammonia. It contains—

Carbon	57·54
Hydrogen	5·98
Nitrogen	13·77
Oxygen	22·71
	100·00

MELANOSIS is a malignant disease distinguished by the deposition of a peculiar soft morbid substance, of which the most prominent character is a deep brown or black colour. This substance may be deposited in separate masses, or infiltrated into the tissue of different parts of the body, or it may be effused from the blood in a fluid form into natural or morbidly formed cavities, or separated from it with the secretions. The deposition of melanotic matter generally takes place successively in numerous parts of the body, producing in all the injurious effects of compression and irritation, till it proves fatal either by its direct influence on some important organ or by the exhaustion which it gradually induces. [Cancer.]

MELANOXIMIDE. [Oxamelanile.]

MELANURENIC ACID. A substance obtained by the action of heat upon urea. It is thought to be identical with ammelide.

MELANURIC ACID ($C_6N_4H_4O_4$). An organic acid, obtained by heating urea beyond its melting point:

$$\underbrace{4(C_2H_4N_2O_2)}_{\text{Urea.}} = \underbrace{C_6H_4N_4O_4}_{\text{Melanuric acid.}} + 4NH_3 + 2CO_2$$

MELASSIC ACID ($C_{24}H_{10}O_{10}$), is formed from cane sugar by the action of heat and alkalies. It has a very dark colour, and when thrown down by hydrochloric acid appears as a black flocculent deposit.

MELENE. [Bees'-Wax.]

MELINUM. [Cadmium.]

MELISSIC ACID. [Melissyl.]

MELISSIN. Synonymous with myricylic alcohol. [Bees'-Wax.]

MELISSYL $\left(\left.\begin{matrix}C_6H_{59}O_2\\C_6H_{59}O_2\end{matrix}\right\}\right)$. The hypothetical radical of melissic acid, one of the family of fatty acids, and obtained by treating myricylic alcohol with soda-lime. The silver salt of this acid has the formula $\left.\begin{matrix}C_{60}H_{59}O_2\\Ag\end{matrix}\right\}O_2$.

MELISSYLIC ALCOHOL. Synonymous with myricylic alcohol. [Bees'-Wax.]

MELITOSE ($C_{12}H_{12}O_{12} + 2$ Aq.). A saccharine substance recently extracted from Australian manna.

MELLIC ACID. [Mellitic Acid.]

MELLITIC ACID (C_8O_6, 2HO). A peculiar organic acid hitherto met with only in a rare mineral, the *honeystone*, or mellitate of ammonia. It is crystalline, reddens litmus strongly, and is not decomposed by boiling nitric or sulphuric acid. It has not yet been very completely examined.

MELLIMIDE. [Paramide.]

MELLON ($C_{18}N_{13}$). The formation of crude mellon has already been noticed. [Cyanogen, *sulphocyanogen*.] When it is fused with three times its weight of pure sulphocyanide of potassium a neutral mellonide of potassium is formed, which is very soluble in hot water, but which separates out on cooling in crystals, containing $K_3, C_{18}H_{13} + 10$aq.

From the formula of the above salt, it will be seen that mellon is a tribasic radical. It has not been isolated in a state of purity, but its compound with hydrogen ($H_3,C_{18}N_{13}$) is readily obtained on passing sulphuretted hydrogen through a solution of mellonide of mercury in hydrocyanic acid. The sulphide of mercury is separated by filtration, and the hydrocyanic acid by the application of a gentle heat. The resulting solution of *hydromellonic acid*, or *hydromellon*, has a very acid taste and reaction, and decomposes the carbonates with effervescence. On evaporation, white flocks first separate, and a white slightly crystalline residue is ultimately obtained.

Neutral mellonide of potassium ($K_3,C_{18}N_{13}+10$ aq.), obtained as above, is converted into cyanuric acid by continued ebullition with hydrochloric acid. Heated with potash it is changed into CYAMELURIC ACID. Two other mellonides of potassium also exist. A monometallic salt containing $KH_2,C_{18}N_{13},+6$ aq., and a bimetallic salt containing $K_2H,C_{18}N_{13}$.

Mellonide of silver ($Ag_3,C_{18}N_{13}$) is a white precipitate obtained on boiling neutral mellonide of potassium with nitrate of silver. *Mellonide of mercury* also is white, and obtained under similar circumstances with bichloride of mercury, and other mellonides may be produced in a similar manner.

MELODY (*μελῳδία*), in music, is Air or Song—a succession of single diatonic sounds, in measured time.

Melody and Air are synonymous terms in modern music, whatever their difference may have been in that of ancient Greece; we therefore shall add but little to what we have already said on the subject under the word AIR, to which the reader is particularly referred.

The question—which exercises most influence over the mind, melody or harmony? has often been agitated, Rousseau taking the lead, who certainly has treated it eloquently, but inconsistently, acting the part of advocate on both sides, and on each refutes himself. He seems to admit, and thus to agree with Metastasio, that music is a kind of language, but overlooks the fact, that, like every other language, it can only affect those who understand it by either studying its principles, as in the case of the few, or by frequently hearing, and thus becoming empirically acquainted with it, as in the case of the many. He does not seem to have considered that simple music, that is, melody, like simple language, makes most impression on the unlearned majority, because easily understood; while complex music, namely, harmony, like high-wrought rhetoric, excites more pleasure in the minds of the instructed minority, who enter into its combinations and perceive all its relations. Melody and harmony may be said to generate each other, the one being a selection of single sounds from a harmonic source, the other a union of two or more melodies simultaneously heard. Thus both are closely connected; and Dr. Burney has remarked, that after melody and harmony have been heard together, nothing can compensate for their separation.

MELOGALLIC ACID. [MELAGALLIC ACID.]

MELON (*Cucumis melo*) is an herbaceous, succulent, climbing or trailing annual, cultivated for its fruit in hot Eastern countries from time immemorial. In regions where most cooling vegetables disappear on the approach of great summer heat and drought, the melon, together with the water-melon (*Cucumis citrullus*), become essential substitutes. The antiquity of the cultivation of melons being so remote, and their dispersion over large portions of Asia and Africa so extensive, their indigenous locality cannot be traced at the present day. They were both introduced into England during the latter part of the 16th century, but it is not known whence.

If the roots be favourably situated, so far as moisture is concerned, the melon will bear a tropical heat; and, generally speaking, it will not succeed perfectly in the open air beyond the 43rd parallel of latitude. Its range of atmospheric temperature may be estimated at between 70° and 80°. The medium in which the roots are placed should of course be more uniform, and about 75° of bottom heat will be found both safe and efficacious.

Light is so essential, that unless the plants are kept near the glass, no tolerable degree of flavour will be acquired. As much of the direct rays of the sun should be admitted as the plants will endure, more especially when the fruit is approaching maturity. A screen may be occasionally necessary, but it should be of very thin texture.

If melon plants were not adapted for a dry atmosphere during a considerable portion of the day at least, they could not exist in the parching climates in which they naturally grow; and therefore a free admission of air is to be recommended, so far as is consistent with the maintenance of a high temperature. The health of the plant soon suffers if evaporation by the foliage is not freely carried on; for it is found that when it is obstructed by continued moist foggy weather, disease commences, and mildew ensues. The regulation of moisture in the artificial atmosphere in which melons are grown, under an English sky, is, of all others, the most insurmountable difficulty. Covering the soil with slates or tiles or with clean gravel has been successfully resorted to as a mode of preventing the air in the frame from being at all times saturated with moisture exhaled from the soil.

Melons will thrive if their roots are actually allowed to extend themselves in water; and in the case of the floating-beds on which they are grown in some parts of Persia, they find their way through the mould and its support into the water. But a drier medium for the roots becomes essential for good flavour in the comparatively close mode which in forcing them it is necessary to adopt in this country, in order to prevent the dissipation of heat, which would otherwise take place from a limited atmosphere the temperature and elasticity of which are so much above that by which it is surrounded.

About four months may be allowed, on an average, when grown in pits, for the period between the sowing of melons and the ripening of the fruit. The middle of January is found to be early enough to sow; and the young plants are so exceedingly tender, that accidents are then very likely to occur to them. It is on this account necessary to make successive sowings, in order to be prepared for replacement, if requisite, and also for continuing the supply throughout the summer. A sowing for the latest crops will require to be made in April.

The seeds should be sown in shallow pans, and transplanted into small pots when their seed-leaves are about half an inch broad. It is best to put only a single transplanted melon into each pot. While this is done in a separate frame, that which is intended for their future growth and fruiting is prepared for their reception, by placing small hills, rather more than a foot high, of light rich mould below each sash, and nearer to the back of the frame than the front. Care must be taken that this mould be of the proper temperature before the young plants are introduced, which is to take place when they have made a few rough leaves. As the roots extend, more soil should be added of a gradually stronger nature; and ultimately the roots should have a depth of about 15 inches of such soil. When water is required, it should never be much below 70°, nor should it exceed 78°. It should not be applied when the air of the frame is at a high temperature from sun-heat. Shading is necessary immediately after watering, when the sun's rays have any great degree of power; unless this precaution is attended to, scorching will be induced, and the red spider will be likely to attack the foliage; other insects to be feared are aphides and thrips. The principal diseases to which melons are subject, are gum and canker. All are more frequent in the plants fruiting on hot-beds, than when treated as climbers.

With regard to pruning and training the *runners* or *vines* of melon plants, it is necessary that a sufficient number of these for filling the frame should be made to ramify as close to the base of the main stem as can be conveniently effected by pinching off the top of the latter when it has made a few joints, or four leaves above the cotyledons; and the laterals, which in consequence become developed, may be again subdivided by a similar process. Blossoms of a monœcious character will soon after make their appearance. The male blossoms, or at least a portion of them, must be retained for the purpose of fertilisation till the requisite quantity of fruit is fairly set, after which those shoots which have only male blossoms may be dispensed with, in order to afford more space for the foliage connected with the fruit. The extremities of the fruit-bearing vines are stopped by pinching at the second or third joint above the fruit. A piece of slate or tile is placed under each fruit for the purpose of keeping it from the damp soil. The heat must be fully maintained, or even considerably increased, as the fruit approaches maturity, in order to allow the admission of a more free circulation of air; but if at the same time the bottom heat be allowed to decline, the plants will become diseased and fall a prey to the mildew or to the red spider.

A very great improvement, however, in the mode of cultivation has been effected by the adoption of the plan of training them off the beds to trellises under glass-houses. The fruit has thus a better opportunity of ripening; and can frequently be cut a month earlier than if ripened on the bed; besides being less liable to damp or rot. The flavour is also finer. By this mode of cultivation, likewise, melons can be brought to fruit in winter, though they will then scarcely acquire the flavour given by a bright sun.

The varieties of melons can scarcely be kept permanent, particularly where many are cultivated, as they hybridise so readily. One of the finest is the Beechwood. Cuthill's Early Cantalope, Bromham Hall, Trentham, Green Fleshed Egyptian, and Green Fleshed Masulipatam, are esteemed excellent. Of the Persian varieties the Green Hoosainee, the large Germek, the Melon of Keiseng, Sweet Melon of Ispahan, and the Geree, are the highest flavoured. The Dampsha is a winter melon. Of water-melons, the Spanish, the Imperial, and the Carolina are among the best.

(*Transactions of Hort. Soc.*; Loudon, *Encyclopædia of Gardening*; Mac Intosh, *Book of the Garden*.)

MELPOMENE. [MUSES.]

MEMOIRS, a term, in its application to a particular species of writing, of French origin, and in appearance properly signifying, as its obvious etymology would denote, a narrative or account mainly or primarily intended for no higher purpose that that of simply recording the facts it embraces, or addressing the one faculty of the memory. Perhaps the modern memoirs may be held to answer pretty nearly to what the Romans understood by *Commentarii* or *Commentaria* (see the meanings of this word in Facciolati, 'Lexic.'), unless when that title was given, in genuine or affected modesty, to writings of a more artificial character than that to which it rightly belonged. The philosophical ends, and the gratification of the imagination and the taste, aimed at in what is properly called a history, are not therefore to be looked for in memoirs, which, when they relate to historical subjects, are in truth not so much history as materials for history. A common description of French works of this kind is 'Mémoires pour servir' (that is, *à l'histoire*). Most frequently too, but not universally, memoirs detail events in which the writer himself has been personally concerned. Very often the work is purely biographical, and not historical at all: and sometimes materials for biography only, and not a biographical work in the proper sense of the term. Sometimes it is neither historical nor biographical, but merely a discourse or statement on some point in science or literature; of this kind are the published memoirs of many academies ('Mémoires de l'Académie des Inscriptions,' for instance), and other literary or scientific societies. It may be noted, that when Horace Walpole wrote his amusing account of the last ten years of the reign of George II., probably soon after the middle of the last century, the word 'Memoires,' which is the title he has given his work, was still so far from being completely naturalised among us, that he has retained the French spelling. We have, however, several English memoirs—such for instance as 'Memoires of the Reigne of King Charles I.,' by Sir Philip Warwick, 1701; 'Memoirs concerning the Affairs of Scotland,' by George Lockhart, Esq., 1714; 'Memoirs of John Ker, of Kersland,' by himself, 1726, &c. The French language is particularly rich in those kinds of historical and biographical materials which are expressed by the term Mémoires.

MEMORIAL. [ANNUITY.]

MEMORY is a name given to one of what are called the faculties of the mind,—the faculty (as it is otherwise expressed) of remembering or recollecting. The word is used to denote at the same time the operation or act of remembering, the state of the mind when it exercises the faculty, as distinguished from the faculty itself; but this last is a derived and by far the rarer use of the word.

What ideas are, how they are first generated, and how afterwards reproduced, are matters the explanation of which belongs to other articles. [ASSOCIATION; IDEA; SENSATION.] But when an idea is reproduced in the mind by any of the ordinary modes of association, and there co-exists with this idea the idea of its having been before present in the mind, this complex state of mind is a case of memory. We are then said to remember the thing (whatever it may be), the idea of which is thus present to the mind. This is an exercise of the faculty of memory.

Mr. Stewart seeks to make a distinction between the memory of events and the memory of things, on the ground that in the former case alone does the idea of past time form part of the complex state of mind. This does not seem to be correct. In all cases of memory, in the memory of things as well as of events, there is (as has been said) the idea of the idea which is now present to the mind having been present before. And this idea is obviously a complex idea, of which the idea of the previous time and the idea of the interval between that and the present time are parts. The particular idea of past time, by means of which Mr. Stewart seeks to make his distinction, belongs to the event that is remembered, and has evidently nothing to do with the mental phenomenon of memory. It is the idea of the event having taken place at a past time, and not (which alone is concerned with the mental phenomenon of memory) the idea of the idea of this event having been before present to the mind.

There is a distinction between *remembering* and *recollecting*, which, though not always observed in conversation, it is yet worth while to notice. The ideas that are remembered either come into the mind without any effort on the part of the person remembering, or with such effort. In the first case the person is more properly said to remember; in the second to recollect. The effort of recollection may be generally described as consisting in seeking out for different ideas which are likely to recall, by any of the ordinary modes of association, the desired idea. What these modes of association are has already been fully explained in two previous articles—ASSOCIATION and DREAMS.

It will be seen that the thing which is essential to the faculty of memory, and which distinguishes it from other faculties of the mind, that indeed which the faculty of memory may be said to be, is the faculty of recognising an idea which has before been present to the mind, as having been before present. But this faculty of recognition can never be exercised until the idea that is to be recognised has been introduced by one of the ordinary modes of association. Thus the principle or (as it may also be called) the faculty of association is necessary to the exercise of the faculty of memory. This principle of association, which, though necessary to the exercise of the faculty of memory, is yet only accidentally connected with that faculty, becomes consequently the basis of mnemonics, or the art of recollection.

The principle of all systems of mnemonics, however much these may differ in complexity, is the same, and simple. It is to select a number of objects which, whether of themselves or by reason of the order of selection, are more easily remembered than those which it is our object to remember, and to associate in our minds each one of the latter set with some one of the former. One of the simplest systems of mnemonics is the plan which used to be resorted to by the ancient orators, of connecting in their minds the different parts of a speech with different parts of the building in which it was delivered. The different systems of 'Memoria Technica' which have been put forth in later times are more complex specimens of the art. Of these, or any one of these, it is unnecessary to give a detailed account here. One of the best known is that of Dr. Grey (London, 1730); another is that by Feinagle.

MENDICITY. [PAUPERISM.]

MENDIPITE. [LEAD.]

MENINGITIS is the term applied to that form of inflammation of the brain which affects the serous membranes by which that organ is surrounded. The following definition has been given of this disease. It is a complex morbid state of the immediate coverings of the brain attended with more or less vascularity and opacity of the arachnoid membrane, and the formation of adventitious products between the arachnoid and pia-mater, and the effusion of pus or serum in the same situation. Acute pain in the head accompanies these lesions, attended with intolerance of light and sound. There is present also watchfulness, delirium, a flushed countenance, and redness of the conjunctivæ, or a heavy suffused state of the eyes. The pulse is quick, and there are frequent spasmodic twitchings or convulsions passing into somnolency, coma, and complete relaxation of the limbs.

This disease comes on at all ages. It attacks children during the period of teething, and comes on in scarlet fever, measles, and other diseases caused by morbid poisons. It is then known under the name of acute hydrocephalus. [HYDROCEPHALUS.] Adults are liable to this disease as the result of typhus, typhoid, and paludal fevers. [FEVERS.] It also comes on as the result of accidents, of intemperance, great mental anxiety, and intense heat of the sun—"coup de soleil."

There is a great difference in the course and character of meningitis, according as it appears in a state of the system in which scrofula is present, and one in which this tendency is absent. Hence the disease is divided by some writers into simple and tubercular meningitis.

All forms of meningitis assume with more or less constancy three stages. 1. The stage of excitement resulting from the inflammation. 2. The stage of compression which indicates that effusion has taken place. 3. A stage in which the symptoms either pass from the last into that of health, or in which the disease progressively terminates in death. In each stage there is a distinct set of symptoms arising from the locality of the disease. The mental, sensorial, and motorial functions are distinctly affected. In the first stage, the *mental* symptoms are either somnolence or wakefulness, or the one alternating with the other. There is delirium which is frequently of a furious character. In the second stage the delirium becomes quieter, or passes into coma, whilst in the third, the mental functions are entirely lost. In the first stage the most remarkable *sensorial* symptom is the intense and continuous pain in the head, which diminishes or disappears in the second stage; whilst in the third stage, complete anæsthesia takes place. The *motorial* symptoms of the first stage are restlessness, twitchings, and vomiting. In the second stage convulsions are frequently present, but in the third stage there is absolute paralysis of all the muscles.

The duration of these stages varies. Sometimes each lasts a week. The pulse in the first stage is from 90 to 100, in the second from 110 to 130, and in the last stage it is scarcely to be counted.

The symptoms of tubercular meningitis differ from those of the simple form, in their being generally less active. They occur in a state of the system which indicates to a greater or less degree the condition of tuberculous cachexia.

In the adult, the symptoms of meningitis have a tendency from the beginning to assume a convulsive or apoplectic character.

The treatment of this disease must in a great measure depend on the nature of the symptoms of the general disease with which it is associated. When it arises from mechanical injuries, it requires a more antiphlogistic treatment than when associated with blood disease. [HYDROCEPHALUS.]

Cerebritis or Encephalitis.—When the substance of the brain is affected independent of the surrounding membranes, the disease is called Cerebritis, or Encephalitis. This disease in its pure form is accompanied by very different symptoms from the first, the most distinguishing of which are the absence of headache and delirium. It consists in an inflammatory action of the vessels which supply the substance of the brain. It may however be combined with inflammation of the meninges, and then the symptoms of the attack are of a combined character. The lesions of the brain discovered after death in cerebritis, are a softening or suppuration of some part of the substance of the brain, which is frequently attended with a dusky redness.

The causes of inflammation of the substance of the brain are much the same as those of meningitis. It occurs at all ages, but adults are more liable to this form of disease than children, and old persons than adults.

There are two forms of this disease observed, the one acute and accompanied with a reddish appearance of the brain after death, the other more chronic, and accompanied with a white appearance of the brain after death.

The symptoms of this disease may be divided into the premonitory, those which are present during the attack, and those which remain after the acute symptoms have passed away.

The premonitory symptoms consist of a loss of mental vigour, a failure of memory, confusion of ideas, irritability of temper, and a sense of general weakness. There is a sense of heaviness, sometimes of heavy pain in the head, and tingling or numbness in the limbs, and often a loss of power in the muscles of one limb or one side.

During the attack the patient has mild delirium, which passes into a condition of insensibility, accompanied with great dulness of thought and perception. There may be an excited sensibility or an absence of sensation. The muscles are either generally or partially paralysed, or there may be spasmodic contractions.

Should the attack continue, many of these symptoms may be relieved, but the functions of the brain are imperfectly performed, and the nervous and muscular functions are irregularly performed.

The treatment of inflammation of the substance of the brain, like that of inflammation of its membranes, must be determined by its causes. If it arises from mechanical injury, an antiphlogistic system must be pursued. If it accompanies the course of any disease produced by a morbid poison, the general symptoms must guide the treatment of the local disease. Where it comes on from mental distress, hard study, intemperance, or other causes, depletory measures must be pursued with great caution. In a large number of these cases a nutritious diet, with tonic medicines, are found to be most beneficial.

MENISCUS. [Lens.]

MENISPERMINE ($C_{18}H_{12}NO_2$) is a white fusible crystallisable alkaloid, forming salts with the acids found in the seeds of the *Menispermum cocculus*, known as *Cocculus Indicus*.

MENSTRUUM. A term used in chemistry to denote any liquid which is employed as the solvent of a body.

MENSURATION is the name given to a branch of the application of arithmetic to geometry, which shows how to find any dimension of a figure, or its area, or surface, or solidity, &c., by means of the most simple measurements which the case will admit of. We need hardly say that a complete treatise on this science would involve every branch of mathematical science. We shall in this article collect together the most important rules, the method of using which will be obvious to all who can employ the trigonometrical tables. By the length of a line we mean the number of linear units contained in it, and by its square and cube the number of units multiplied by itself once and twice.

The measurement of lengths and directions resolves itself for the most part into the determination of a side or angle of a triangle, when other sides or angles are given. The triangle may be either on a plane or on a sphere; but we refer the latter to Sphere, since the use of spherical trigonometry can only be well explained in connection with astronomy. Let a, b, c be the sides of a triangle, and A, B, C the opposite angles. If the triangle be right angled at C, we have the following formulæ:—

$$a=c\sin A=c\cos B=b\tan A=b\cot B$$
$$b=c\sin B=c\cos A=a\tan B=a\cot A$$

$$c=\frac{a}{\sin A}=\frac{a}{\cos B}=\frac{b}{\sin B}=\frac{b}{\cos A}$$

$$c=\sqrt{(a^2+b^2)}\quad a=\sqrt{(\overline{c+b}\,.\,\overline{c-b})}\quad b=\sqrt{(\overline{c+a}\,.\,\overline{c-a})}$$

The preceding formulæ contain the solution of every case of right-angled triangles.

We now pass to oblique-angled triangles, of which there are four cases.

1. Given the three sides, a, b, and c, to find the angles. Let the perpendicular let fall from C upon the longest side c divide it into two segments α and β adjacent to a and b, and let b be $\not< a$. Then the equations

$$\beta+\alpha=c,\ \beta-\alpha=\frac{(b-a)(b+a)}{c}$$

(in which $\beta-\alpha$ is easily found by logarithms), will give β and α. Then

$$\cos B=\frac{\alpha}{a}\quad \cos A=\frac{\beta}{b}\quad C=180^\circ-(A+B)$$

Another method is as follows. Compute M from the following,*

$$s=\frac{a+b+c}{2}\quad M=\sqrt{\left(\frac{\overline{s-a}\,.\,\overline{s-b}\,.\,\overline{s-c}}{s}\right)};\ \text{then}$$

$$\tan\tfrac{1}{2}A=\frac{M}{s-a}\quad \tan\tfrac{1}{2}B=\frac{M}{s-b}\quad \tan\tfrac{1}{2}C=\frac{M}{s-c}$$

2. Given two sides a and b, and the remaining angle C, required c, A, and B. Firstly, to find the angles, determine

$$\tfrac{1}{2}(B+A)\ \text{from}\ \tfrac{1}{2}(B+A)=\tfrac{1}{2}(180^\circ-C)$$

$$(B-A)\ \text{from}\ \tan\tfrac{1}{2}(B-A)=\frac{b-a}{b+a}\,.\cot\tfrac{1}{2}C$$

$$A=\tfrac{1}{2}(B+A)-\tfrac{1}{2}(B-A);\ B=\tfrac{1}{2}(B+A)+\tfrac{1}{2}(B-A)$$

$$c=b\,\frac{\sin C}{\sin B}=a\,\frac{\sin C}{\sin A}$$

To find the third side without the aid of the angles, assume

$$\sin\theta=\frac{\sqrt{(ab)}\,.\,2\cos\tfrac{1}{2}C}{a+b},\ \text{then}\ c=(a+b)\cos\theta;$$

or

$$\tan\theta'=\frac{\sqrt{(ab)}\,.\,2\sin\tfrac{1}{2}C}{a-b},\ \text{then}\ c=\frac{a-b}{\cos\theta'}$$

3. Given a, b, and the angle A, to find the rest:

$$\sin B=\frac{b}{a}\sin A,\ C=180^\circ-(A+B),\ c=\frac{a\sin C}{\sin A}$$

When $a<b$, B may be taken either acute or obtuse; and the problem has two solutions.

4. Given a, and two of the angles, to find the rest. It is unnecessary to distinguish the angles given, as two immediately determine the third.

$$b=a\,\frac{\sin B}{\sin A},\ c=a\,\frac{\sin C}{\sin A}$$

The area of the triangle is

$$\frac{ab\sin C}{2}\ \text{or}\ \frac{bc\sin A}{2}\ \text{or}\ \frac{ca\sin B}{2}\ \text{or}\ \sqrt{(s\,.\,\overline{s-a}\,.\,\overline{s-b}\,.\,\overline{s-c})}$$

The perpendiculars let fall from the vertices A, B, and C, upon the opposite sides, are severally $2\sqrt{(s\,.\,\overline{s-a}\,.\,\overline{s-b}\,.\,\overline{s-c})}$ divided by a, b, and c.

$$\text{Diam. of inscribed circle}\ 2\sqrt{(\overline{s-a}\,.\,\overline{s-b}\,.\,\overline{s-c}\div s)}$$

$$\text{Do. of circumscribed circle}\ \frac{a}{\sin A}\ \text{or}\ \frac{b}{\sin B}\ \text{or}\ \frac{c}{\sin C}$$
$$\text{or}\ abc\div 2\sqrt{(s\,.\,\overline{s-a}\,.\,\overline{s-b}\,.\,\overline{s-c})}$$

Segments of c made by perpendicular from C,

$$\text{Adjacent to}\ a,\ \frac{c^2+a^2-b^2}{2c};\ \text{to}\ b,\ \frac{c^2+b^2-a^2}{2c}.$$

Segments of c, by line bisecting C,

$$\text{Adjacent to}\ a,\ \frac{ac}{a+b};\ \text{to}\ b,\ \frac{bc}{a+b}.$$

$$\text{Line bisecting}\ C=\frac{2\sqrt{(abs\,.\,\overline{s-c})}}{a+b}=\frac{2ab}{a+b}\cos\tfrac{1}{2}C$$

$$\text{Line bisecting}\ c=\tfrac{1}{2}\sqrt{(2a^2+2b^2-c^2)}.$$

The area of a rectangle (in square units), and that of a parallelogram, is the product of the units in the base and perpendicular distance of the opposite sides. But if two sides only be parallel, half the sum of the parallel sides must be multiplied by the perpendicular distance between them. In other cases, the figure must be measured by dividing it into triangles, except when it is either a four-sided figure capable of inscription in a circle, or a regular polygon. Every triangle is half of the rectangle contained by any one of its sides, and the perpendicular let fall from the opposite vertex.

If a, b, c, and d be the sides of a four-sided figure inscribed in a circle, and s their half-sum, the area is

$$\sqrt{(\overline{s-a}\,.\,\overline{s-b}\,.\,\overline{s-c}\,.\,\overline{s-d})}.$$

If a be one of the sides of a regular polygon of n sides, the area of the figure and the diameters of the circumscribed and inscribed circles are

$$\frac{na^2}{4}\cot\left(\frac{180^\circ}{n}\right),\ a\div\sin\left(\frac{180^\circ}{n}\right),\ \text{and}\ a\div\tan\left(\frac{180^\circ}{n}\right)$$

Tables connected with this subject are given in the article Regular Figures. For the method of measuring irregular areas, see Quadratures, Method of.

The whole of the measurement of the circle depends upon the ratio of the circumference to the diameter, which is called π, and is 3·1415927 very nearly, or $\frac{22}{7}$ roughly, or $\frac{355}{113}$ very nearly. [Angle.] So many simple derivations from this number are practically useful, that we shall give a table of them, accompanied by their logarithms, first giving a method of multiplying and dividing by π, which is a correction of the use of $\frac{22}{7}$. To multiply by π, multiply by 22 and divide by 7; from the result take one-eighth of the hundredth part of the multiplicand as a correction; the result is too great only by about its 200,000th part. To divide by π, multiply by 7, divide by 11 and 2, and to the result add the eighth part of the thousandth part of the dividend; the result is too small by very nearly its 100,000th part.

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* This convenient adaptation of a well-known formula is found, we believe, for the first time in Professor Wallace's work on Mathematical Theorems and Formulæ (Longman, 1839).

The table just referred to is as follows:—

	Number.	Logarithm.
π	3·1415927	0·4971499
$\pi \bullet 2$	1·5707964	0·1961199
$\pi : 4$	·7853982	9·8950899
$\pi : 6$	·5235988	9·7189986
$\pi : 8$	·3926991	9·5940599
$\pi : 12$	·2617994	9.4179686
$4\pi : 3$	4·1887902	0·6220886
2π	6 2831853	0·7981799
4π	12·5663706	1·0992099
$1 : 6\pi^2$	·01688686	8·2275490
$1 : \pi$	·3183099	9·5028501
$4 : \pi$	1 2732395	0·1049101
$1 : 4\pi$	·0795775	8·9007901
π^2	9·8696044	0·9942997
$\sqrt{\pi}$	1·7724539	0·2485750
$\sqrt[3]{\pi}$	1·4645919	0·1657166
$\sqrt{(1 : \pi)}$	·5641896	9·7514251
$\sqrt{(4 : \pi)}$	1·1283792	0·0524551
$\sqrt{(1 : 4\pi)}$	·2820946	9·4503951
$\sqrt[3]{(6 : \pi)}$	1·2407010	0·0936671
$\sqrt[3]{(3 : 4\pi)}$	·6203505	9·7926371
Hyp. log. π	1·1447299	0·0587030

To find the circumference from the diameter, multiply by π; to find the diameter from the circumference, multiply by $1 : \pi$; to find the area from the diameter, multiply the square of the diameter by $\pi : 4$; to find the area from the radius, multiply the square of the radius by π; to find the diameter from the area, multiply the square root of the area by $\sqrt{(4 \cdot \pi)}$; to find the area from the circumference, multiply the square of the circumference by $1 : 4\pi$; to find the circumference from the area, multiply twice the square root of the area by $\sqrt{\pi}$; to find the ordinate perpendicular to a diameter, take the square root of the product of the segments into which it divides the diameter.

To find the area contained between two concentric circles, multiply the product of the sum and difference of the radii by π.

The arc of a circle and its subtended central angle are connected as follows: the arc which is equal to the radius subtends an angle of 57°·3 very nearly; or it may be easily remembered as 57 degrees and *three-tenths* of a degree, diminished by one-*fourth* of a minute and one-*fifth* of a second, being 57° 17′ 44″·8, or 206264″·8. To find an angle from its arc (the radius being known), multiply the arc by 57·3, and divide by the radius; the result is too great by about three-quarters of its 10,000th part, and is in degrees and decimals of a degree. To find the arc from its angle, turn the angle into degrees and decimals, multiply by the radius, and divide by 57·3: the result is now too small by about three-quarters of its 10,000th part.

To find the area of a sector, find the arc (if only the angle be given), and multiply it by half the radius. To find the area of a segment contained between an arc and a chord, find the sector, and from it subtract the triangle formed by the terminal radii and the chord. [SEGMENT.]

To find the length of an arc, when the radius is not known, measure the chord of the arc, and the chord of its half; from eight times the chord of the half subtract the chord of the whole, and take one-third of the remainder. For an arc not exceeding 60°, the error is less than the 7000th part of the whole.

The preceding are the principal rules of mensuration, of which the necessity occurs in the elementary parts of the subject: those which remain are connected with solid geometry, and the most essential are as follows:—

The number of cubic units in the content of a rectangular solid (or parallelopiped; there is no shorter term for this most elementary form of solid figures, unless the reader will follow us in calling it a *right solid*) is the product of the number of linear units in its three adjacent sides. The content of a prism or cylinder is the product of the number of square units in its base and the number of linear units in its altitude. The content of a pyramid or cone is one-third of the base multiplied by the altitude. The surfaces of a prism or pyramid must be found by computing those of their several faces. The surface of a common cylinder (not including the bases) or of a right prism is the circumference of the base multiplied by the altitude; that of a common cone is half the product of the circumference of the base and the slant side.

The following formulæ relate to the sphere. To find the surface from the radius, multiply the square of the radius by 4π, or the square of the diameter by π; to find the content from the radius, multiply the cube of the radius by $4\pi : 3$, or the cube of the diameter by $\pi : 6$; to find the radius from the surface, multiply the square root of the surface by $\sqrt{(1 : 4\pi)}$; to find the diameter, multiply the square root of the surface by $\sqrt{(1 : \pi)}$; to find the radius from the content, multiply the cube root of the content by $\sqrt[3]{(3 : 4\pi)}$; to find the diameter, multiply the cube root of the content by $\sqrt[3]{(6 : \pi)}$; to find the surface from the content, multiply the cube root of the square of six times the content by $\sqrt[3]{\pi}$; to find the content from the surface, multiply the square root of the cube of the surface by $1 : 6\sqrt{\pi}$. [SPHERE.]

For other formulæ and methods, the detached articles on the different subjects may be consulted; or Hutton's or Bonnycastle's elementary works on mensuration. Many works on mensuration have been published of late years.

MENTHA PIPERI'TA (Peppermint), a plant common in many parts of Britain, but cultivated for medical purposes. The dried plant, which is more powerful than the fresh, is of a lively green, with a peculiar aromatic odour, and a pleasant camphor-like taste, at first burning, but at last causing an enduring sensation of cold in the mouth. The dried herb is used for the preparation of a distilled water, and of a volatile oil, from which oil spirits or essence of peppermint is prepared. Of the oil several varieties occur in commerce, the German, English, American, and Chinese. Twenty pounds of the herb yield from four to six drachms; but if the flowers be also distilled, the same weight will yield four ounces. It is often adulterated with oil of turpentine, oil of marjoram, and absolute alcohol. When pure it is of a whitish yellow, yellow, or even green colour; odour very strong, taste burning, camphor-like, causing a sense of coldness in the mouth. The oil is at first limpid, but becomes thicker, like a fixed oil. European oil does not deposit a stearopten, but the American easily forms long colourless four-sided prisms, which possess the odour of the oil. The American oil is more soluble in alcohol than the German; specific gravity 0·92, but when rectified 0·90. The Chinese variety consists almost entirely of a stearopten. The action on the human system of any of the preparations of mint is stimulant and antispasmodic. The oil is used to be added to drastic or griping purgatives, and in other cases. It proved of considerable utility in bringing about reaction in the collapsed stage of Asiatic cholera.

MENTHA PULE'GIUM (Pennyroyal), an indigenous species of mint, smaller than most of the others, and of which the entire herb, except the root, is officinal. The odour is strong and peculiarly aromatic; taste herbaceous and bitterish. It has a stimulant and antispasmodic property, similar to most mints, but is supposed to possess also a specific power over the uterus, which has been much overestimated. A distilled water, a spirit, and volatile oil are prepared from it, as from the *Mentha piperita*. A popular compound called hysteric water, consists of the distilled water of pennyroyal, and compound spirit of bryony, a very unsafe mixture.

MENTHA VI'RIDIS (Spearmint), a plant of Britain, very much resembling *M. piperita*; the colour however is of a deep green. It is also frequently confounded with *M. Crispa*, than which it has a stronger and more agreeable odour, but weaker than peppermint. It has not the aromatic odour of that plant, nor does it leave the sense of coolness in the mouth. From it are prepared a distilled water, a spirit, and a volatile oil, which are used as the former.

MENTHENE ($C_{20}H_{18}$). A hydrocarbon produced by the action of anhydrous phosphoric acid upon concreted essential oil of mint. It is a transparent fluid oil, possessing an agreeable odour.

MENU. [MANU.]

MENUIE. [COLOURING MATTERS.]

MENYANTHES TRIFOLIA'TA (bog-bean, corrupted into buck-bean, *Marsh Trefoil*,—officinal part, the leaves), a plant common in our bogs, and hence called bog-bean, as its leaves resemble the common bean. The leaves are ternate, petiolate, and even when dried have a fine green colour, but are without odour; they possess an enduring bitter taste. One hundred parts of the fresh herb dry into thirty-nine; ten pounds of the dried plant yield two pounds and three-quarters of extract. It contains an extractive (Menyanthin), which Brandes says forms a white, transparent, and, when highly dried, pulverisable mass of an intense degree of bitterness. Troommsdorff says he obtained only a yellowish brown, clear, very viscid, not pulverisable, bitter extract.

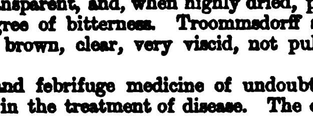
It is a tonic and febrifuge medicine of undoubted efficacy, but greatly neglected in the treatment of disease. The chief use said to be made of the large quantity annually collected is to substitute it for hops in brewing, a proceeding which is both illegal and detrimental to the beer, since, though bitter, it does not possess the aromatic quality of the hop.

MENYANTHIN is a non-azotised uncrystallisable neutral principle found in the common buck-bean, *Menyanthes trifoliata*.

MEPHITIC AIR. [CARBONIC ACID.]

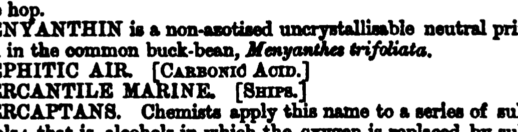
MERCANTILE MARINE. [SHIPS.]

MERCAPTANS. Chemists apply this name to a series of sulphur-alcohols; that is, alcohols in which the oxygen is replaced by sulphur. The relation of the alcohols to the mercaptans will be most clearly seen by the following comparison of the formulæ of vinic alcohol and mercaptan.



$$\underbrace{\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}O_2}_{\text{Vinic alcohol.}} \qquad\qquad \underbrace{\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}S_2}_{\text{Mercaptan.}}$$

The mercaptans are produced by saturating an alcoholic solution of potash with sulphuretted hydrogen, and then distilling it with the chlorine compounds of the alcohol radicals. Thus vinic mercaptan is produced by the following reaction:



$$\underbrace{\left.\begin{matrix}K\\H\end{matrix}\right\}S_2}_{\substack{\text{Sulphhydrate}\\\text{of potassium.}}} + \underbrace{\left.\begin{matrix}C_4H_5\\Cl\end{matrix}\right\}}_{\substack{\text{Chloride of}\\\text{ethyl.}}} = \underbrace{\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}S_2}_{\text{Mercaptan.}} + \underbrace{KCl}_{\substack{\text{Chloride of}\\\text{potassium.}}}$$

Vinic mercaptan, which was the first investigated and most important of these compounds, and is frequently called *mercaptan*, gives the name to the series. The mercaptans are colourless liquids, possessing a horribly fœtid alliaceous odour. They act like acids upon metallic oxides, forming *mercaptides*. This is especially so in the case of oxide of mercury, hence the origin of the name—*mercurium captans*. The following are the chief known mercaptans :

Methyl mercaptan	$\left.\begin{matrix}C_2H_3\\H\end{matrix}\right\}S_2$
Ethyl mercaptan	$\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}S_2$
Amyl mercaptan	$\left.\begin{matrix}C_{10}H_{11}\\H\end{matrix}\right\}S_2$

MERCAPTIDES. [MERCAPTANS.]

MERCATOR'S PROJECTION. [MAP.]

MERCHANT SEAMEN. [SHIPS.]

MERCHANT SHIPPING. [SHIPS.]

MERCURIAMINE. [MERCURY.]

MERCURY (Hg.) *Quicksilver.* The history of this well-known metal, a description of the sources whence it is obtained, its physical properties, and a list of the minerals in which it occurs have already been given under MERCURY, in NAT. HIST. DIV. An interesting statistical account of the most important of all the mercury mines, namely, those of Almaden in Spain, is also given under ALMADEN in GEOG. DIV. It is here, therefore, only necessary to treat of its chemical properties and the action of various substances upon it by virtue of which compounds of the metal are obtained.

The equivalent of mercury is 200. By combining with one or with two equivalents of other bodies it forms two classes of salts, known as *protosalts* and *bisalts*. Sometimes the equivalent of mercury is assumed to be 100, and then the first class of salts containing two such equivalents to one of another body are necessarily termed *disalts* or *subsalts* ; while the second class, containing only one such equivalent to each equivalent of another body, are consequently termed *protosalts*. This want of uniformity in the nomenclature of salts of mercury is to be deprecated, inasmuch as it is confusing to students, and has also frequently led to serious errors when employed by those who, like medical men and compounders of medicine, have necessarily but a partial knowledge of chemistry. A method now very generally adopted, by which the inconvenience is obviated, consists in adding to the word *mercur* the terminals that are commonly used for similar purposes—namely, *ic* and *ous*. The first or lower class of salts are thus mercur*ous* salts, and the second, or higher, mercur*ic* salts.

Mercury and *oxygen* form two compounds.

1. Protoxide of mercury	HgO
2. Binoxide of mercury	HgO_2

1. *Protoxide of mercury* (HgO). *Black oxide, grey oxide, suboxide,* or *dinoxide, of mercury. Mercurous oxide.* This oxide is best obtained by triturating calomel with dilute caustic potash or soda, and well washing and drying the resulting oxide. The operation should be conducted as much as possible in the dark, as the oxide is decomposed by the influence of light, into metallic mercury and binoxide. Though itself unstable, it forms very stable salts, called *salts of mercurous oxide* or shortly, *mercurous salts.*

2. *Binoxide of mercury* (HgO_2). *Peroxide, red oxide, yellow oxide,* or *protoxide, of mercury. Mercuric oxide.* This oxide may be made in several ways. The alchemists used to keep mercury at a boiling heat for a month, or longer, in a matrass, or a flask with a tolerably long neck, but having free communication with the air. It thus slowly absorbed oxygen, becoming converted into binoxide and was called by them *mercurius precipitatus per se.* It is now however generally prepared by calcination from mercuric nitrate when it has a bright orange colour, and is in the state of shining crystalline grains. Sometimes it is precipitated from a solution of a persalt of mercury by caustic potash or soda; it then differs from the crystalline variety in being converted into oxalate of mercury by the action of oxalic acid.

Binoxide of mercury darkens in colour when heated, but again becomes red on cooling. When ignited it is resolved into metallic mercury and oxygen gas. Chlorine acts upon it, especially when moist, hypochlorous acid and an oxychloride of mercury being formed. Reducing agents also readily attack it. It is a powerful base forming *salts of mercuric oxide,* or shortly, *mercuric salts.*

Mercury and *sulphur* form two sulphides corresponding to the two oxides :—

1. Protosulphide of mercury	HgS
2. Bisulphide of mercury	HgS_2

1. *Protosulphide of mercury* (HgS). *Mercurous sulphide. Ethiop's mineral.* This compound is precipitated when sulphuretted hydrogen is passed through a solution of a mercurous salt. It is also frequently made by triturating two hundred parts of mercury with sixteen of sulphur. It is almost as unstable as the protoxide.

2. *Bisulphide of mercury* (HgS_2). *Mercuric sulphide. Cinnabar. Vermilion.* This is the most common ore of mercury. [MERCURY, in NAT. HIST. DIV.] It is largely used as a pigment, but for this purpose is usually prepared artificially. The Chinese are very successful manufacturers of vermilion: the following is supposed to be the process they adopt. One hundred parts of mercury and thirty-eight of sulphur are triturated for two or three hours; twenty-five parts of solid caustic potash and one hundred and fifty of water are then added, and the whole heated to about 115° Fahr. for several hours. It must be constantly stirred at first, and, when the desired tint is obtained, removed from the fire and well washed with cold water.

In this country vermilion is commonly made by triturating mercury with about one sixth of its weight of sulphur, and then subliming. The beauty of the tint is said to depend upon the amount of levigation to which the sublimate is afterwards subjected.

Protosulphide of mercury is also thrown down when sulphuretted hydrogen gas is passed through a solution of a mercuric salt. It is black, but may be made to assume a red colour by sublimation. It is insoluble in aqueous solutions of the alkalies and in all acids except aqua regia. It is dissolved however in hydrochloric acid when arsenic or antimonic acids and some other oxidising agents are present.

Mercury and *iodine* form :—

1. Protoiodide of mercury	HgI
2. Sesqui-iodide of mercury	Hg_2I_3
3. Biniodide of mercury	HgI_2

1. *Protoiodide of mercury.* (HgI). *Green,* or *diniodide of, mercury. Mercurous iodide.* Prepared by triturating an equivalent of mercury with one of iodine, the mixture being moistened with a little alcohol to keep down the temperature and consequently prevent too rapid action and decomposition. It is also precipitated when a mercurous salt is mixed with solution of iodide of potassium. It is somewhat unstable.

2. *Sesqui-iodide of mercury* (Hg_2I_3). *Mercuroso-mercuric iodide.* Precipitated when a solution of iodine in iodide of potassium is added to a solution of mercurous nitrate. Alcohol extracts no mercurous iodide from this compound—a proof that it is not a mere mixture of mercurous and mercuric iodide.

3. *Biniodide of mercury* (HgI_2) *Mercuric iodide.* Prepared as the protoiodide, two equivalents of iodine being used, or by precipitation from a mercuric salt by iodide of potassium. It is at first salmon-coloured, but by molecular alteration speedily becomes a magnificent scarlet. It sublimes in yellow tabular crystals, but on rubbing, scratching, or merely agitating, undergoes the alteration just mentioned and becomes scarlet; in short, biniodide of mercury is, in crystallographic language, dimorphous. During the change heat is evolved.

Double salts of biniodide of mercury with other compounds of mercury and with the alkaline iodides may be easily formed.

Mercury and *bromine* form compounds very much resembling the iodides.

Mercury and *chlorine* form two important chlorides :—

1. Protochloride of mercury	$HgCl$
2. Bichloride of mercury	$HgCl_2$

1. *Protochloride of mercury* (HgCl). *Subchloride* or *dichloride of mercury. Mercurous chloride. Calomel.* This compound of mercury has been known for nearly three centuries. It was first called *calomel* (from *καλὸs, good,* and *μέλας, black*) by Sir Theodore Turquet de Mayenne, though for what reason is not satisfactorily known. It occurs native [MERCURY, in NAT. HIST. DIV.] but for use in medicine is always prepared artificially. This is sometimes accomplished by adding chloride of sodium to a solution of a mercurous salt, and well washing and drying the precipitate. More usually, however, it is obtained by submitting to the action of heat a mixture, in equivalent proportions, of chloride of sodium and protosulphate of mercury; double decomposition takes place, protochloride of mercury sublimes and sulphate of soda remains. If the vessel in which this operation is conducted be small, the calomel condenses in brilliant quadrilateral prisms terminated by four-sided pyramids; but if the receiver be capacious, and especially if it be filled with steam, the calomel condenses in the form of an exceedingly fine white or slightly buff-tinted powder. By the latter modification of manufacture the trouble of grinding is avoided.

Calomel is tasteless and insoluble in water. The fixed alkalies convert it into protoxide. Ammonia changes it to *black precipitate* or *mercurous amidochloride* ($HgCl + HgNH_2$). It is very soluble in strong solutions of alkaline salts, but much less so in dilute solutions; decomposition into metallic mercury and mercuric salt accompanies the solution.

2. *Bichloride of mercury* ($HgCl_2$). *Perchloride of mercury. Mercuric chloride. Corrosive sublimate.* This compound may be formed by the direct union of its constituents, but is usually prepared by submitting to an elevated temperature a mixture, in equivalent proportions, of bisulphate of mercury and chloride of sodium. The following equation exhibits the reaction :—

$$HgO_2, 2SO_3 + 2NaCl = HgCl_2 + 2(NaO, SO_3).$$

Corrosive sublimate crystallises in white needles or in a semi-vitreous mass. It has an acrid, peculiarly metallic taste that is very unpleasant. It is soluble in three parts of boiling, and eighteen to twenty of cold water. Hot alcohol dissolves its own weight of this salt, and cold alcohol one-third of its weight; ether also readily dissolves it: indeed, agitation with ether will abstract corrosive sublimate from an aqueous solution.

Double salts of bichloride of mercury with alkaline chlorides readily crystallise out when a solution containing them is evaporated. *Sal alembroth* is such a double salt containing ($HgCl + 3NH_4Cl$). It crystallises in flat tables.

White precipitate ($HgCl_2 + Hg2NH_2$) is thrown down when ammonia is added to a solution of corrosive sublimate.

Mercuric oxychlorides, containing two, three, or four equivalents of binoxide to one of bichloride, are precipitated when bicarbonate of potash and bichloride of mercury are brought together under various conditions.

Mercury and *Cyanogen* form only one salt, viz.:

Bicyanide of mercury ($Hg\,Cy_2$). *Mercuric cyanide.* Usually made by boiling bisulphate of mercury with half its weight of ferrocyanide of potassium and four times its weight of water. It crystallises out in white needles on cooling the solution. It may also be made by dissolving binoxide of mercury in hydrocyanic acid, or by boiling Prussian blue with binoxide of mercury.

Bicyanide of mercury is soluble in alcohol and in eight parts of cold water; but in a much smaller quantity of boiling water. Its solution is very poisonous, and is neither precipitated by alkalies nor by any metallic salts, except those of palladium. By heat it is converted into metallic mercury and cyanogen gas.

There are two *sulphates of mercury* :—

1. Protosulphate of mercury	HgO, SO_3
2. Bisulphate of mercury	$HgO_2, 2SO_3$

1. *Protosulphate of mercury* (HgO, SO_3). *Sub-* or *di-sulphate of mercury. Mercurous sulphate.* Formed on triturating bisulphate of mercury with as much mercury as it already contains. It is but slightly soluble in water.

2. *Bisulphate of mercury* ($HgO_2, 2SO_3$). *Persulphate of mercury. Mercuric sulphate.* A mixture of two parts of mercury and three of sulphuric acid is boiled to dryness, when a white crystalline powder remains of the above composition. Water decomposes it into an acid salt ($HgO_2, 6SO_3$) that remains in solution, and a yellow basic salt ($3HgO_2, 2SO_3$), called *turpeth mineral,* which is precipitated.

There are many *nitrates of mercury.* The two most important are:—

1. Protonitrate of mercury	HgO, NO_5
2. Binitrate of mercury	$HgO_2, 2NO_5$

1. *Protonitrate of mercury* ($HgO, NO_5 + 2Aq.$). *Sub-* or *di-nitrate of mercury. Mercurous nitrate.* Formed by digesting metallic mercury in excess of cold dilute nitric acid. It crystallises in transparent prisms. Water decomposes it into a yellow, basic, insoluble salt, and an acid soluble salt. If excess of mercury is used in the preparation, crystals are obtained containing ($4HgO, 3NO_5 + 2Aq.$).

2. *Binitrate of mercury* ($HgO_2, 2NO_5 + Aq.$). *Pernitrate of mercury. Mercuric nitrate.* Best obtained by dissolving binoxide of mercury in nitric acid. It may also be made by dissolving mercury in boiling nitric acid, but it has not then a constant composition.

Chromates of mercury. An alkaline chromate throws down a bright red precipitate from a solution of a mercurous salt. It contains $4HgO, 3CrO_3$. Heated with nitric acid, it is converted into HgO, CrO_3. *Mercuric chromate* is also a red powder precipitated when an alkaline chromate is added to a solution of a mercuric salt.

Fulminate of mercury. [FULMINATING MERCURY.]

Acetates of mercury. There are two:—

1. Protoacetate of mercury	$HgO, C_4H_3O_3$
2. Binacetate of mercury	$HgO_2, 2C_4H_3O_3$

1. *Protoacetate of mercury* ($HgO, C_4H_3O_3$). *Sub-* or *din-acetate of mercury. Mercurous acetate.* Precipitated in micaceous scales, when a soluble acetate is added to a strong solution of a mercurous salt. It is insoluble in alcohol, and decomposed by heat.

2. *Binacetate of mercury* ($HgO_2, 2C_4H_3O_3$). *Peracetate of mercury. Mercuric acetate.* Made by dissolving binoxide of mercury in excess of hot acetic acid, or by mixing hot solutions of acetate of potash and binitrate of mercury, a little acetic acid being also added. It crystallises in white, inodorous, flexible scales.

Mercuramine is the provisional name given to a very powerful base, produced on agitating precipitated binoxide of mercury with solution of ammonia in a well stoppered bottle. It contains $2HgO_2, NH_3, 2HO$, and may be viewed as the hydrated oxide of $HgO_2, HgNH_2$. It is a white powder, very unstable, decomposing when exposed to light, or with a series of slight explosions when triturated in a mortar. It absorbs carbonic acid from the air as quickly as slaked lime does, and forms definite salts with acids.

Mercury with chalk is a preparation used in medicine. It is made by rubbing chalk and mercury together until the latter is so minutely divided as not to be perceptible by the naked eye. It is sometimes called *gray powder,* and from exposure to light is very liable to contain protoxide and binoxide of mercury.

Mercury with magnesia is a preparation similar to that just described. The mixture of the two is facilitated by the introduction of a little manna, which is subsequently got rid of by washing with water.

Other preparations containing finely divided metallic mercury are also used in medicine. Such are the pill, ointment, and cerate of mercury.

Tests for mercury. The salts of mercury are distinguished by being volatilised by heat, and by yielding globules of metal when heated with carbonate of soda in a narrow test tube. From solution the metal is precipitated with its characteristic appearance on to a piece of gold (such as a half-sovereign) when the liquid is rubbed on the gold with a key or other piece of steel. Metallic copper also causes the deposition of mercury from solution with characteristic lustre. Protochloride of tin has the same effect. Sulphuretted hydrogen throws down a black precipitate.

Proto- or *mercurous salts* are distinguished by turning black on the addition of an alkali. From solution, hydrochloric acid throws down a white precipitate (calomel), and iodide of potassium a green precipitate.

Per- or *bi-* or *mercuric salts* give no precipitate with hydrochloric acid, a yellow (binoxide) with fixed alkalies, white with ammonia, and scarlet with iodide of potassium.

Estimation of mercury. This is usually effected in the metallic form. It is brought to this state either by protochloride of tin, or by heating with quick lime in a glass tube through which a current of hydrogen is passing, the mercury being collected in a glass bulb.

Sometimes mercury is precipitated by sulphuretted hydrogen, and estimated in the state of bisulphide. In that case it is always advisable to wash the sulphide with sulphite of soda solution, which has the effect of dissolving any free sulphur.

MERCURY-ALLYL. [ORGANOMETALLIC BODIES.]

MERCURY-ETHYL. [ORGANOMETALLIC BODIES.]

MERCURY-METHYL. [ORGANOMETALLIC BODIES.]

MERCURY, *Medical Properties of.* In a purely metallic state, mercury, when taken into the human stomach, produces no effects except such as are owing to its mechanical properties; such as when it is improperly employed to remove the obstruction of the bowels in lead, or painters', cholic. Nevertheless it may become oxidised, and, by combining with some of the acids of the stomach, occasion violent disorder. Even its external application leads to similar results, from the metal first becoming oxidised, then absorbed, and producing the same effects as if taken by the mouth. The preparations of mercury differ very much in the degree of their action, both according to the nature of the combination, and also of the dose employed or the mode of administration. The milder preparations seem only to increase the natural and healthy actions of the organs of the body, particularly the secreting and exhaling organs; while the more active, if not given in very minute doses, destroy the texture and impair the function of many organs, both those with which they are brought into immediate contact, and others which they affect by sympathy or other means. No medicinal substance is capable of producing so much benefit, none is so frequently abused, or so fertile a source of injury, as mercury. Its mode of action is little understood, but its effects are often sufficiently obvious. A brief statement of the most important of these effects is all that can be given here.

When mercury, triturated with chalk or magnesia, or with confection of roses (which is the case when it is made into *blue* pill), is taken in moderate dose into the stomach, it does not seem to make any immediate sensible impression, unless that organ be in a state of morbid sensibility, when it is apt to cause heartburn, nausea, or disturbance of the bowels. It may be repeated at proper intervals, and the individual, especially if robust, appears only to have an increased appetite and more ready digestion. This is more particularly the case when corrosive sublimate (bichloride of mercury) is given in very minute doses. Even the introduction of mercury into the body by friction over parts where the skin is thin, would seem to increase for a time the activity of the whole system. To whatever surface applied, the absorbents would appear to lay hold of it, and carry it into the circulating mass. Owing to peculiarity of constitution (idiosyncrasy) a very minute quantity of mercury produces in some individuals very striking effects, either violent salivation, disturbance of the bowels, or other inconveniences, accompanied by great debility. This result is quite distinct from the effects of an overdose of some of the more active forms, which produces actual poisoning, or from the effects of the too long continued administration of some of the mild preparations. Children, owing to the irritability of their bowels, are not so apt to be salivated as adults, and more mercury can be borne in warm than in cold countries.

When a single dose of mercury is given, it is generally one of the preparations which act on the bowels, either alone, or in combination with or followed by some other purgative medicine, and little permanent effect is observed; but repeated small doses, especially if hindered from passing off by the bowels, by combination with opium, excite arterial commotion, and end by establishing a febrile movement. The pulse is full and more frequent, the animal heat augmented, the secretion from the skin abundant, at last followed by thirst, restlessness, and sleeplessness. This disturbance frequently lasts some time, even after the medicine has been discontinued, and is occasionally accompanied with determination or congestion of blood either towards the lungs, abdomen, or brain, followed sometimes by hæmorrhage from various organs. Blood drawn during a mercurial course is generally found covered with a buffy coat, the same as is the case in inflamma tory diseases. On the salivary glands the effects are most conspicuous; they become irritated, more sensible, turgid, and pour out abundant saliva, which, on standing, deposits flakes of coagulated albumen. The breath at the same time acquires a peculiar fetor (called mercurial); the gums are swollen, with a peculiar line running along the margin, but pale and tender; the teeth become loose; and the tongue and lining membrane of the mouth are covered with ulcers.

The general commotion of the system often proves a powerful agent in the cure of many diseases; but occasionally it becomes too great, and requires to be moderated. Not only must the exhibition of the mercury be suspended for a time in such cases, but very plethoric persons must be bled, and put on the antiphlogistic plan even before beginning its use. The warm bath, diluent drinks, and a milk or farinaceous diet, with cool air, are proper means of lessening the violence of its action. Iodine is said to have the power of expediting the removal of the mercury out of the system.

The effects just mentioned show the necessity of abstaining from its administration when there is a tendency to hæmorrhage (especially of the lungs), or a disposition to consumption, or if there exist a scrophulous constitution, or the person be affected with sea scurvy; also during certain states of the female system, and during pregnancy or suckling.

When the use of mercury is too long continued, or it is given in too strong doses, its stimulating action appears to fatigue the system, and to pervert the function of assimilation, both immediately in the blood and also in the different organs and tissues. Hence the individual loses his muscular power, becomes pale, tumid, and puffy, or else greatly emaciated. The brain and spinal chord are irritated; the limbs exhibit involuntary tremblings, such as are observed in the workers in the mercurial mines, in makers of looking-glasses, and other trades in which mercury is largely used; and all the tissues acquire a morbid susceptibility. The blood is found to be deteriorated, and to have lost its ordinary consistence, and the person appears to be affected with scurvy or consumption. The inconsiderate use of mercurial preparations, especially of corrosive sublimate, often occasions chronic inflammation of the stomach, causing indigestion, and alterations or thickenings of the coats of the stomach. Diseases of the brain not unfrequently result from an improper use of mercury. Lastly, a peculiar affection of the skin often occurs from the abuse of this substance.

In the treatment of diseases, four distinct effects may be obtained from the employment of mercurial preparations. 1. By some of them the intestinal canal is irritated, and the expulsion of its contents occasioned. 2. Others are used to create a general commotion of the system, to rouse the lymphatics, and excite both the secreting and excretory glands. 3. To control or altogether change the action of the capillary vessels, when that is extreme and tending to the effusion of serum, and more especially of coagulable lymph. With this may perhaps be joined the action of the mercury as an alterative. 4. What is regarded as its specific effect in bringing about the cure of some peculiar diseases.

Calomel, or the protochloride of mercury, is the preparation most employed as a purgative; it influences the intestinal canal along its whole length, and excites the liver and other glands to secretion. It is of very great utility, not only at the commencement of fevers, but even during their course, either when given alone or in conjunction with some other purgative. It is not admissible if the tongue be very red and sensible, and a similar state of stomach be presumed to exist. In many eruptive fevers, especially scarlet fever, its early and even free employment is productive of the best results. In the yellow and many other fevers of hot climates it is indispensable. In these diseases, mercury is introduced into the system by every means; and whenever the patient is salivated recovery may be expected. In many of the less rapid fevers of Europe the like benefit follows its use.

During the inflammatory and turgescent stage of hydrocephalus acutus, or water on the brain, calomel, alone or with digitalis, is frequently efficacious in saving the patient; at the same time other forms of mercury, especially the liniment, may be used. In the wasting or atrophy of children, the steady daily use of calomel and rhubarb produces the best results, if proper dietetical means be adopted.

These measures should at no time be resorted to except under the direction of responsible medical attendants. The unnecessary use of mercury, when some other purgative would have answered as well, is much to be reprobated, and not only injures the constitution of children, but, if they are teething at the time, it leads to the early decay of their teeth. (Bell 'On the Teeth.')

Persons under the influence of mercury, even when a single dose has been taken as a purgative, are very liable to take cold, especially from wet. This must be carefully guarded against. The bichloride of mercury (or corrosive sublimate) seems not to dispose the system so much to be hurtfully impressed by cold, and is therefore well suited to camp and navy practice. Besides, if given in sufficiently small doses, it is perhaps the best of all the preparations to use as an alterative, especially in cases of chronic inflammation or thickening of the tissues, such as the heart. This particular preparation of mercury seems to exert a beneficial effect in restraining the escape of the albumen of the blood by the kidneys, in the disease called albuminuria, or Bright's disease. It should be given in very minute doses, the $\frac{1}{20}$th of a grain, dissolved in distilled water, about half an hour after each meal. If any signs of salivation manifest themselves it should instantly be suspended. Indeed from time to time it should be discontinued, as no system can bear the continuous use of mercury.

Mercury has a great power of checking the deposition of coagulable lymph, and controlling changes in the organic particles of bodies, both vegetable and animal. One of the most valuable uses of mercury is connected with this power of changing the action of the capillaries when that action is extreme, or when there is a tendency to pour out serum in excess, or effuse coagulable lymph. In some inflammations the action of the vessels is so violent as to pour out their contents, and this leads to obstructions or changes of structure which derange the functions, or even speedily occasion death. Thus, in croup, coagulable lymph is effused in the windpipe, obstructing respiration; in peritonitis, or inflammation of the outer lining of the intestines, lymph is poured out, agglutinating the folds of the intestines; in iritis the same happens, closing the pupil of the eye and destroying vision. In all these cases, after free venesection, or even without it, calomel given very freely will hinder further effusion, and even cause the absorption of what has already escaped from the vessels, as may often be seen when the iris of the eye is inflamed.

Many serious chronic diseases are removed by a judicious and persevering use of mercury; but these can neither be enumerated here, nor can even the most general rules be attempted to be laid down. (Holland, 'Medical Notes;' 'On Mercurial Medicines;' and Teale, 'On Neuralgic Diseases.')

The specific employment of mercury is still less suitable to be discussed here. It may be remarked, however, that the opinion for the necessity of giving mercury in any quantity is now altogether exploded.

It is not necessary to dwell on any of the other preparations of mercury, many of which are valuable, either alone or as additions to other substances. Calomel frequently greatly assists in promoting the action of other medicines, particularly diuretic medicaments. How far calomel, either in small frequently repeated doses or in very large ones, was really useful in Asiatic cholera, cannot be ascertained. But where it has been given, and salivation has occurred, or the mercurial fetor of the breath perceived, recovery has almost invariably ensued. The employment of corrosive sublimate in the arts depends in some cases on principles explained above. Thus it checks fermentation, and opposes the formation of new compounds: hence, when applied in solution to timber, it prevents the dry-rot from occurring by solidifying the albumen of the wood. [ANTISEPTICS.] In cases of poisoning by it, the antidotes most proper are those substances which contain albumen, such as white of egg, milk, flour, &c. [ALBUMEN.] (See 'Observations Relative to the Science and Art of Medicine,' by William Wegg, M.D., London, 1851.)

MERCURY, the planet nearest to the sun. Its orbit being entirely within that of the earth, it never recedes to the point of the heavens opposite to the sun, but is always found within 29° of the sun. Hence it is only visible to the naked eye in the evening, when it is to the east of the sun, and near to its greatest distance (or elongation) from the sun; so that the sun can descend sufficiently below the horizon to allow the planet to be seen just before its setting: similarly, it is only visible in the morning (before sunrise), when it is near its greatest elongation westward of the sun. The phases of Mercury are not visible without a telescope. The apparent diameter of Mercury varies from 5 to 12 seconds; the real diameter is ·398 of that of the earth, or about 3140 miles. Its bulk is to that of the earth as 63 to 1000; its mass is reckoned at the two-millionth part of that of the sun. It revolves on an axis, the inclination of which to the ecliptic is not determined, in $24^h\ 5^m\ 28^s{\cdot}3$. It has seven times the light and heat of the earth.

The transits of Mercury, or passages of the planet over the sun's disc, take place when the conjunction (the inferior conjunction, as it is called, Mercury being between the earth and the sun) happens at the time that the planet is near its node. These transits are not so useful in the determination of the sun's parallax or the longitude of the place of observation as those of Venus: we shall therefore refer the account of such transits in general to the latter planet. The following are, according to Delambre, the times of the transits which will yet take place in the present century (civil time at Paris):—

1861	12 Nov., 7½ A.M.	1881	8 Nov., 1 A.M.
1868	5 Nov., 7 A.M.	1891	10 May, 3 A.M.
1878	6 May, 7 P.M.	1894	10 Nov., 6½ P.M.

Elements of the Orbit of Mercury.

Epoch, 1799, December 31, 12^h mean astronomical time at Seeberg.

Semiaxis major ·3870938, that of the earth being assumed as the unit.

Excentricity ·2041704; its secular increase (or increase in 100 years) ·0000039.

Inclination of the orbit to the ecliptic $7^\circ\ 0'\ 5''{\cdot}9$; its secular increase $18''{\cdot}4$.

Longitudes from the mean equinox of the epoch: (1.) of the ascending node, 45° 57′ 9″·0; its secular increase (combined with the precession), 4215″·1; (2.) of the perihelion, 74° 20′ 6″·0; its secular increase (combined with the precession), 5602″·9; (3.) of the planet (mean), 108° 4′ 48″·3.

Mean sidereal motion in one mean solar day, 4° 5′ 32″·558; in 365¼ it is 53° 42′ 47″·65 more than 4 complete revolutions; sidereal revolution, 87·96926 mean solar days.

MERCURY, TRANSIT OF. [Mercury; Venus.]

MERCURY, DEPRESSION OF. [Barometer.]

MERGER. It is somewhat difficult to give an exact definition of this legal term. In order to form an accurate notion of what is meant by it, the notion of the legal term estate [Estate] is a necessary preliminary. "The accession of one estate to another, or, more accurately speaking, the circumstance that two estates immediately expectant on each other, meet or are united in the same person, is the cause of the merger." (Preston.) These words express in general terms the conditions necessary in order that merger may follow as a consequence. This consequence, called merger, is that the preceding estate ceases to exist, and the estate in which this preceding estate is said to be merged continues to be exactly the same as it was before that union which was the cause of merger.

It is necessary to add to this general description of the cause of merger, that the estate which is prior in point of time must not be greater (in legal estimation) than the estate which immediately follows: it may be either equal or less, but not greater. Also the estates must both be vested estates, and both must be legal or both equitable estates.

Thus, if A is tenant for life, with reversion to B in fee, and A surrenders his estate to B, or B releases his estate to A, in either case the life-estate is merged, the consequence of which is that the estate in reversion immediately becomes a fee in possession. It seems that one term of years will merge in another, and a larger term in a less: at least this is the case when the second term is a term in reversion. Thus, if A is tenant for years, with reversion to B for years, and A surrenders or assigns his term to B, the term which belonged to A is merged. There is one exception to this rule: if the estate of A is derived from the estate of B as an underlease, the original term of B is not abridged by such merger. In fact, merger, in the proper sense of the term, can never apply to a surrender or assignment of an estate in land to the person by whom, and out of whose larger estate that smaller estate was granted. But if A who is seised in fee, leases first to B for five hundred years, and then to C for ten years, by way of immediate reversion, and C assigns his term to B, the estate of B is merged in that of C, which becomes an estate in possession, and can have no longer duration than ten years. Opinions vary as to the question whether a term can merge in a term in remainder.

Estates tail are not subject to merger; an exception which is a necessary consequence of the form of the gift to the heirs in tail, so long as there are any. Formerly, if an estate tail had become a base fee by the tenant in tail levying a fine, such base fee would merge by union with the immediate reversion in fee. But by a recent statute (3 & 4 Wm. IV. c. 74), such base fee will not merge in the reversion in fee, but shall be "enlarged into as large an estate as the tenant in tail, with the consent of the protector, if any, might have created by any disposition under this Act, if such remainder or reversion had vested in any other person."

If the two estates, the union of which in one person might otherwise cause merger, do not unite in him in the same right, there is no merger.

The various exceptions to the general principles of merger are numerous enough to form the subject of an entire treatise. The whole subject is discussed at great length in the third volume of Mr. Preston's 'Treatise on Conveyancing.'

The origin of the doctrine of merger is uncertain, and no hypothesis seems fully to explain all the cases of merger as now settled. In the case put by Bracton (fol. 12), the termor for years who had become the feoffee of the land, is considered as having, by the acceptance of the freehold, renounced the term (ex quo idem B se tenuit ad feoffamentum, tacite termino renuntiavit). The origin of merger is discussed in Preston's third volume, chap. iii., &c.

MERIDIAN (*meridies*, mid-day). In the heavens the meridian is the circle which passes through the pole and the zenith of the spectator: on the earth it is the circle which passes through the pole and the spectator's position; consequently the terrestrial meridian is the section of the earth made by the plane of the celestial meridian.

The circle derives its name from being that on which the centre of the sun is found at mid-day, or real noon. In the case of a fixed star, the time at which its altitude is greatest is the moment of its coming on the meridian; but in that of the sun or a planet, the orbital motion prevents the moment of its culmination (or coming on the meridian) from being exactly that of its attaining its highest point; though the difference is not worth noting for ordinary purposes. [Sphere, Doctrine of the.]

MERLON. [Epaulement.]

MESACONIC ACID ($C_{10}H_8O_8$) *Citracartic Acid*, is an acid described by Gottlieb, and obtained by the action of nitric acid on citraconic acid. It forms minute crystals, sparingly soluble in water. [Citric Acid.]

MESITE. One of the constituents of wood naphtha. It is a very mobile fluid, boiling at 158° Fahr., and possessing an ethereal odour. *Mesitene* is another similar fluid obtained from wood naphtha, and boiling at 145° Fahr.: both are soluble in 3 parts of water.

MESITENE. [Mesite.]

MESITYL-HYPOPHOSPHOROUS ACID ($C_6H_6O_2$, HO, PO). This acid, along with *mesityl-phosphoric acid* ($C_6H_6O_2$, HO, PO_3) and *mesitic aldehyde* ($C_6H_4O_2$), are obtained by certain reactions with acetone; their composition cannot be considered as established.

MESITYL-PHOSPHORIC ACID. [Mesityl-hypophosphorous acid.]

MESITYLOLE ($C_{18}H_{12}$), is obtained from the distillation of acetone with fuming sulphuric acid. Thus, 3 equivalents of acetone = $3(C_6H_6O_2)$, yield 6H O and mesitylole. The atoms of hydrogen may be substituted by chlorine, bromine, and nitrous acid.

MESMERISM, the term usually applied to the phenomena of animal magnetism, after the name of its first propounder, Anton Mesmer. (Mesmer, in Biog. Div.) Perhaps the time is not yet come when the combined physiological, pathological, and psychological phenomena of mesmerism can be rationally explained. At any rate it involves a series of facts in relation to the human system which historically have a high interest. Not that these are all new since the time of Mesmer; but he first gave a systematic character to the phenomena, and, with the air of a philosopher, sought to refer them to scientific principles. The following is his account of the agent which he supposed to exist:—

"Animal magnetism is a fluid universally diffused; it is the medium of a mutual influence between the heavenly bodies, the earth, and animated bodies; it is continuous, so as to leave no void; its subtilty admits of no comparison; it is capable of receiving, propagating, communicating all the impressions of motion; it is susceptible of flux and of reflux. The animal body experiences the effects of this agent; by insinuating itself into the substance of the nerves it affects them immediately. There are observed, particularly in the human body, properties analogous to those of the magnet; and in it are discerned poles equally different and opposite. The action and the virtues of animal magnetism may be communicated from one body to other bodies, animate and inanimate. This action takes place at a remote distance, without the aid of any intermediate body; it is increased, reflected by mirrors; communicated, propagated, augmented by sound; its virtues may be accumulated, concentrated, transported. Although this fluid is universal, all animal bodies are not equally susceptible of it; there are even some, though a very small number, which have properties so opposite, that their very presence destroys all the effects of this fluid on other bodies. Animal magnetism is capable of healing diseases of the nerves immediately, and others mediately. It perfects the action of medicines; it excites and directs salutary *crises* in such a manner, that the physician may render himself master of them; by its means he knows the state of health of each individual, and judges with certainty of the origin, the nature, and the progress of the most complicated diseases; he prevents their increase, and succeeds in healing them, without at any time exposing his patient to dangerous effects or troublesome consequences, whatever be the age, the temperament, and the sex. In animal magnetism nature presents a universal method of healing and preserving mankind." (*Mémoire sur la Découverte du Magnétisme Animal*, par M. Mesmer, Paris, 1779, p. 74, et seq. *Ibid. Avis au Lecteur*, p. 6.)

The mode adopted by Mesmer of bringing the magnetised under the influence of the magnetic fluid was peculiar. In the middle of each room in which the persons to be treated were collected was placed a large circular vessel, made of oak about a foot or a foot and a-half in height: the interior of this vessel was filled with pounded glass, iron filings, and bottles containing magnetised water arranged symmetrically: the cover or upper part of the vessel was pierced with numerous holes, in which were placed polished iron rods of various lengths, bent, and capable of being moved: this was called the *baquet*, or magnetic tub. The patients were placed in successive rows around the baquet, and each had one of the rods of iron, the end of which he applied to the part of his body which was supposed to be the seat of his disease: a cord passed around their bodies united the patients to one another, and sometimes they formed a second chain by taking hold of each other's thumbs. A pianoforte was placed in the corner of the room, and various airs were played upon it, sometimes accompanied with the sound of the voice and song. The magnetiser held in his hand a polished and pointed rod of iron from ten to twelve inches long. The baquet was a reservoir of magnetic virtues; its interior arrangement was for the purpose of concentrating the magnetic fluid; the rods were the conductors for transmitting it. The cords around the bodies of the patients and the other chain of connection by the thumbs were for increasing the effects of the fluid by communication. The magnetiser had previously charged the pianoforte with magnetic fluid; the person playing on it was incessantly giving out more; the sound conducted it to the patients. The purpose of the music was to put the patients into a state of quiet; to give them agreeable sensations, and thus to dispose them to receive the magnetic action. The purpose of the magnetiser's rod was to concentrate to a point the fluid which issued from him, and thus to render it more powerful. The sick persons arranged in great numbers and in several rows around the baquet, thus receive the magnetism by all these means; by the iron rods which convey to them that of the baquet; by the cords wound round their bodies; by the connection of the thumbs which communicate to them that of their neighbours; by the sound of the pianoforte or of an agreeable voice diffusing the magnetism in the air; by the finger and rod of the magnetiser moved before their faces, above or behind their heads, and on the diseased parts, always observing the direction of the poles; by the eye of the magnetiser; but above all by the application of his hands and the pressure of his fingers on the hypochondria and on the regions of the abdomen; an application often continued for a long time, sometimes for several hours. Meanwhile the patients in their different conditions present a varied picture. Some are calm, tranquil and experience no effect: others cough, spit, feel slight pains, local or general heat, and have sweatings; others again are agitated or tormented with convulsions. These convulsions are remarkable in regard to the number affected with them and to their duration and force; and are characterised by the precipitous involuntary motions of all the limbs and of the whole body, by the constriction of the throat, by the leaping motions of the hypochondria and the epigastrum; by the dimness and wandering of the eyes; by piercing shrieks, tears, sobbing, and immoderate laughter. They are preceded or followed by a state of languor and reverie, a kind of depression, and even drowsiness. The smallest unforeseen noise occasions shudderings; even a change of tone and measure in the airs played on the pianoforte influences the patients, a quicker motion agitating them more and renewing the vivacity of their convulsions. Nothing is more astonishing than the spectacle of these convulsions; one who has not seen them can form no idea of them. The spectator is equally astonished at the profound repose of one part of the patients and the agitation of the rest; at the various accidents which are repeated and the sympathies which are established. Some patients devote their exclusive attention to each other, rushing towards one another, smiling, speaking with affection, and mutually soothing their *crises*. All are under the power of the magnetiser; it matters not in what state of drowsiness they may be—his voice, a look, a gesture brings them out of it.

Such is the account of M. Bailly, who, together with Lavoisier, Franklin, and other distinguished men, were appointed by the French government to examine into these splendid pretensions. These commissioners report—"That this pretended agent certainly is not common magnetism, for that, on examining the baquet, the grand reservoir of this wonderful fluid, by means of a needle and electrometer, not the slightest indication of the presence either of common magnetism or of electricity was afforded; that it is wholly inappreciable by any of the senses or by any mechanical or chemical process; that they tried it upon themselves and upon many others without being able to perceive anything; that on blindfolding those who seemed to be most susceptible to its influence, all its ordinary effects were produced when nothing was done to them but when they imagined they were magnetised, while none of its effects were produced when they were really magnetised, but imagined nothing was done; that, in like manner, when brought under a magnetised tree nothing happened if the subjects of the experiment thought they were at a distance from the tree, while they were immediately thrown into convulsions if they believed they were near the tree, although really at a distance from it; that, consequently, the effects actually produced were produced purely by the imagination; that these effects, though some cures might be wrought, were, not without danger, since the convulsions excited were often violent and exceedingly apt to spread, especially among men feeble in body and weak in mind, and almost universally among women: and finally, that there were parts of the operation of magnetising which might readily be turned to vicious purposes, and that immoral practices had already actually grown out of them."

Notwithstanding such a report from men so well qualified to form a judgment, animal magnetism continued to flourish to such a degree, that Dr. Franklin, writing some time after this report had become public, and adverting to the proneness of mankind to credulity, states that Mesmer was at that time getting more money in the shape of fees than all the regular physicians in Paris put together. Mesmerism in this form did not become popular in England. There was at one time some danger of it, but it was prevented by the skilful management of a physician of eminence. A man of the name of Perkins had invented a wonderfully convenient instrument for collecting, condensing, and applying animal magnetism, composed of a metallic substance, and called the metallic tractor. For this instrument he had obtained a patent, and its virtues he set forth in a work bearing the following title—'The Efficacy of Perkins's Patent Metallic Tractors in various Diseases of the Human Body and Animals; exemplified by two hundred and fifty cases from the first literary characters in Europe and America. With a Preliminary Discourse in Refutation of the Objections made by Interest and Prejudice to the Metallic Practice.' Dr. William Falconer, of Bath, having made tractors of wood so exactly resembling the patent tractors that it was impossible for the eye to distinguish between the one and the other, tried, in conjunction with Dr. Haygarth, the effect of these fictitious tractors on a large scale on patients in the Bath Hospital, and produced precisely the same effects with the fictitious as with the genuine, affording a demonstration that whatever effects were produced, were produced solely by the imagination. The publication of these cases put an end to the virtues of the metallic tractors in England.

Since the death of Mesmer, however, animal magnetism has had directed towards it a great amount of attention, and has been investigated by physiologists of eminence, and used as a curative agent by many medical men.

One of the first publications in this country on this subject was by Mr. Richard Chenevix, a Fellow of the Royal Society, who published a series of papers in the 'London Medical and Physical Journal' for 1829, entitled 'On Mesmerism, improperly denominated Animal Magnetism.' He performed numerous experiments, which were witnessed by many medical men, and amongst others by Dr. Elliotson. In 1836 Mr. Colquhoun published a work on animal magnetism, entitled 'Isis Revelata,' which attracted considerable attention to the subject, and contained as an appendix a translation of a report of a second French commission appointed to investigate this subject in 1831. This was followed by the arrival of Baron Dupotet in London, who performed many experiments, some of which were witnessed by Dr. Elliotson, who immediately undertook the further investigation of the subject. The result of the experiments of Dr. Elliotson, which were published in the 'Lancet,' produced a great sensation, and phenomena which had hitherto been regarded as impossible were constantly produced. Communications were also made at this time to various medical journals of remarkable cases, and among others were some from Mr. Herbert Mayo, then professor of physiology at King's College, London. In 1840 a work was published by the Rev. Chauncy Hare Townshend, entitled 'Tracts on Mesmerism, with reasons for a dispassionate inquiry into it.' This work contained many cases and facts with regard to the phenomena of animal magnetism. In 1841 M. La Fontaine, a Frenchman, visited England, and commenced giving public lectures on mesmerism and exhibitions of its phenomena. Whilst in Manchester he attracted the attention of the late Mr. Braid, a surgeon residing there, who, having repeated and modified variously the original experiments of the mesmerisers, published a work on the subject in 1843, entitled 'Neurypnology, or the Rationale of the Nervous Sleep.' Since this time various public lecturers have appeared, and have created a general interest on the subject. A great impulse was given to it by the publication of a series of letters in the 'Athenæum' from Miss Martineau, who attributed her cure from a long-standing ailment to the influence of animal magnetism. Subsequently to this, the subject was taken up in Edinburgh, and found a scientific advocate and exponent in the late Dr. Gregory, professor of chemistry in the University of Edinburgh.

The phenomena presented by persons under the influence of animal magnetism are various, as well as the modes by which the phenomena are produced. Mesmer and his followers on the Continent, and most of those who have practised mesmerism in this country, have produced its effects by placing themselves near to the individual to be mesmerised, and making downward passes with their hands over their bodies without touching them, but looking at them at the same time intently in the face. This is found to affect the individual in a space of time varying from two or three minutes to half an hour. All persons are not however susceptible of the influence, and if an effect is not produced in the course of half an hour, the effort is abandoned. Mr. Braid however, in the course of his inquiries, found that a second individual was not necessary to the successful development of mesmeric phenomena, and that by causing a person to sit still, and simply directing his attention, by means of the eyesight, to some particular object, as a lancet-case or a cork, all the effects of the passes and intense looking of the operator could be produced. This induced him to give another name, Hypnotism, to the state in which persons are thus placed.

The effects of the passes or fixed attention on persons of nervous susceptibility are various. Writers on animal magnetism distinguish many stages. The following classification is by Kluge, a German writer on the subject, and gives a tolerably correct estimate of the effects which have been observed in mesmerised individuals:—

First degree:—Called *waking*, presents no very remarkable phenomena. The intellect and the senses still retain their usual powers and susceptibility.

Second degree:—Half-sleep, or imperfect crisis. Most of the senses still remain in a state of activity, that of vision only being impaired, the eye withdrawing itself from the power of the will.

Third degree:—The magnetic or mesmeric sleep. The organs of the senses refuse to perform their respective functions, and the patient is in an unconscious state.

Fourth degree:—The perfect crisis, or simple somnambulism. In this stage the patient is said to "wake within himself," and his consciousness returns. He is in a state which can neither be called sleeping nor waking, but which appears to be something between the two.

Fifth degree:—Lucidity, or lucid vision. This is called in France, and mostly in this country *Clairvoyance*; in Germany, *Hellsehen*. In this state the patient is said to obtain a clear knowledge of his own internal mental and bodily state, is enabled to calculate with accuracy the phenomena of disease which will naturally and inevitably occur, and to determine what are their most appropriate and effectual remedies. He is also said to possess the same faculty of internal inspection with regard to other persons who have been placed in mesmeric connection (*en rapport*) with him.

Sixth degree :—Universal lucidity; in German, *Allgemeine Klarheit*. In this state the lucid vision becomes greatly increased, and extends to objects whether near or at a distance.

Such are the states of the system recognised by mesmerists, and works on the subject abound with cases illustrative of each of these six degrees. However, there are many who practise mesmerism who are sceptical with regard to the real existence of the two last degrees, although such cases are recorded by the best authorities on animal magnetism.

One of the most singular statements with regard to mesmerism is its application to phrenology. It is asserted that persons in the sleep-waking state, when that region of the head is touched or pointed at by the mesmeriser which is over the seat of the supposed phrenological organs in the brain, will exhibit the mental emotions and states which are peculiar to the exercise of these organs. Thus when the organ of language is touched, the patient talks; when wit, he laughs; when benevolence, he is kind, and so forth. Such cases are attested by Dr. Elliotson, Mr. Braid, Mr. James Simpson, and others.

The mesmeric state has been applied mostly to the cure of disease, for which purpose it was used by Mesmer when it first attracted public attention. It has also been used for the purpose of producing sleep during surgical operations, as well as a means of divination for the purpose of ascertaining past and future events. A case of this kind was related by Miss Martineau, in which one of her attendants was asserted to be able in the mesmeric condition to predict future events. The class of diseases which have been cured by its means are those which are known to medical men as functional nervous diseases. Various nervous diseases, such as paralysis, epilepsy, &c., come on from changes in the structure of various organs, but these are not susceptible of benefit from the mesmeric state. It is in those cases where no structural lesion can be supposed to exist, and which often yield to sudden changes of the mind from various causes of excitement, and which frequently cease without obvious cause, that the disease has yielded to this remedy.

Many theories have been propounded in order to embrace the facts of animal magnetism. Mesmer and his immediate followers attributed them to the action of a subtle fluid in the bodies of animals, which enabled them to exercise an influence on each other at a distance, just as a magnet affects iron; hence he called it animal magnetism. This hypothesis of a nervous fluid susceptible of being influenced and producing an influence more or less modified, was adopted by most writers on mesmerism till the appearance of Mr. Braid's experiments. The mesmeric state having been produced by Mr. Braid without any influence from a second person, he accounted for the phenomena by supposing that there was "a derangement of the cerebro-spinal centres and of the circulatory and respiratory and muscular systems, induced by a fixed state, absolute repose of body, fixed attention, and suppressed respiration concomitant with that fixity of attention." He further added, that in all cases he believed "that the whole depended on the physical and psychical condition of the patient, arising from the causes referred to, and not at all on the volition or passes of the operator throwing out a magnetic fluid or exciting into activity some mystical universal fluid or medium."

Whilst there can be little doubt with regard to many of the facts recorded on this subject, they have been so remarkably misrepresented through the feelings of those who have observed and narrated them, that men of science, disgusted with the imposture of some and the credulity of others, have generally shunned its investigation, and turned a deaf ear to what they consider the pretensions of its professors. There have been recorded several instances in which mesmeric cases have been tested by unprejudiced observers, and which have led to the conclusion that in these particular cases either imposition was practised or a false conclusion had been drawn from the facts. In the case of two girls put to the test by Mr. Wakley, editor of the 'Lancet,' and recorded in that periodical for September 1, 1838, there was strong reason to believe that many of the phenomena attributed to animal magnetism were assumed at the volition of the patient. Another instance is recorded by Sir John Forbes, in the same journal for August 3, 1844, in which he tested the powers of *clairvoyance* of a French youth named Alexis. In these experiments, which were conducted before many observers, the youth entirely failed to give evidence of any extraordinary mental powers during the mesmeric state.

A more scientific aspect was given to the whole of the phenomena of animal magnetism by M. Reichenbach, a distinguished German chemist, who imagined he had discovered a new force in nature, which he called Od force, or Odyle. This he regarded as a peculiar force in nature, whose presence could only be detected by persons of a highly susceptible nature, and all his experiments upon the subject were performed through the agency of such individuals. He applied his conclusions to the explanation of the phenomena of animal magnetism, but the circumstance of all his experiments having been performed through the medium of others, and those confessedly in a morbid state, has led to the very general rejection of his theory.

Another form which the public exhibition of animal magnetism has assumed is that which is called "electro-biology." In the public performances of lecturers on this subject, persons are made to gaze for a certain length of time on a piece of money which is placed in their hands. In susceptible individuals this produces a kind of cataleptic sleep, from which they pass to a sleep-waking state. It is in this condition they exhibit all the phenomena of the mesmeric state. They become the victims of every suggestion made to them by the operator. If he tells them they are drunk, they stagger; if he says a glass of water is sweet, bitter, acid, or strong, they appear to believe it. In this state, also, they are capable of exerting an amount of muscular power of which they are utterly incapable whilst in their natural state. The mode of producing this sleep is nothing more than that which had been discovered by Mr. Braid, and the term electro-biology was only adopted to awaken attention to an old subject.

Although not essentially connected with mesmerism, from the absence of the characteristic sleep, yet having a relation to mesmerism in the mental states of those who are operated upon, we may here refer to table-turning, table-talking, spirit-rapping, and magnetometry.

The process of table-turning consists in the moving a table round, as the result of several persons joining their hands and resting them upon the table. They then resolve that the table shall move in one direction, and without any conscious effort on their part, the table moves. Professor Faraday showed by means of an ingenious instrument, that muscular force was exerted by the individuals surrounding the table, and that, when it was all made to tell in one direction the table moved in that direction, but if no force was exerted, or the force was exerted in different directions, the table did not move. In this case it was clearly shown that the persons operating were under the influence of a suggestion which, without Professor Faraday's instrument, they could hardly have suspected.

An instrument called a magnetometer was invented, which was supposed to indicate delicate magnetic states of the system. It consisted merely of a piece of sealing-wax, or wood, suspended on a string of silk. A variety of curious effects were said to be arrived at by this instrument. It moved in one direction when held by males, and another when held by females. It was influenced by persons holding different kinds of metals in their hands, and so on. The whole of this subject, however, was exploded when it was found that no definite effects were produced when persons were blindfolded. Here, again, the operators were the victims of their suggestions. They exercised their volition unconsciously, and attributed it to the existence of a mysterious force. This explanation serves to explain the further absurdities of table-talking and spirit-rapping. In the former the stopping of the turning-table when a question was asked, was certainly the result of the suggestion in the minds of those who were turning the table, and thus answers were got to all kinds of questions.

In spirit-rapping there appears to be more than mere self-delusion. In this case a person called a medium undertakes to communicate with spirits. The presence of the spirit is indicated by raps. These raps are undoubtedly performed by the medium, whilst the answers given to questions put by deluded persons, are dependent on the medium shrewdly taking advantage of their being under the influence of their own suggestions.

With regard to the mesmeric sleep, there can be no doubt that it is a real phenomenon, as well as the sleep-waking condition. It is, however, when persons are in this condition that they become, as it were, the slaves of suggestion. It is thus that the electro-biologist plays upon them at his will, and it is in this state that they become clairvoyant and universally lucid under the same law of suggestion.

The known fact of the great increase of force that takes place in normal conditions of the system when the whole attention is concentrated on an idea, serves to explain the feats of strength performed by persons in the sleep-waking state. The whole of this curious subject has been ably discussed by Dr. Carpenter in an article in the 'Quarterly Review.'

Although so many of the phenomena of mesmerism admit now of a rational explanation, it is still practised as a mystery, and large portions of the public give credence to the most marvellous assertions of those who practise it. In many of the cases exhibited before the public there is really no sleep-waking at all, and the persons who exhibit clairvoyance, and a power of reading thoughts without language, and books without eyes, are clever conjurors, who are perfectly awake, and exhibit none of the genuine symptoms of those psychological states which have excited so much interest in the minds of an uneducated public. [SOMNAMBULISM.]

MESOLABIUM, an old name for any geometrical construction or proportion for finding two mean proportionals between two given lines.

MESOXALIC ACID (C_6O_8, 2HO). When a saturated solution of alloxanate of baryta or strontia is heated to ebullition, a precipitate is obtained which consists of a mixture of mesoxalate, alloxanate, and carbonate of the base employed. On evaporating the barytic solution crystalline crusts are formed composed of urea and mesoxalate of baryta. When these are digested in alcohol the urea is dissolved, and the mesoxalate of baryta is unacted upon. If a solution of alloxan is gradually added to a boiling one of acetate of lead, a heavy granular precipitate of mesoxalate of lead is formed, and there remains in the acid liquor merely the excess of acetate of lead and pure urea. The mesoxalic acid is obtained by treating the mesoxalate of lead or baryta with dilute sulphuric acid.

The properties of the solution thus obtained are, that it is very acid, reddens vegetable colours, crystallises, and produces, when saturated with ammonia, as alloxanic acid does, white precipitates in the salts of lead, lime, baryta, and strontia. These precipitates are soluble in acids and in a large quantity of water. A solution of mesoxalic acid may be boiled and evaporated without decomposing.

The distinguishing character of this acid is the mode in which it acts on the salts of silver. When a salt of silver is added to mesoxalate of ammonia, a yellow precipitate is formed, which becomes black, and is reduced with effervescence when the mixture is gently heated.

MESSENGER. [Bankrupt.]

MESSENGERS AT ARMS are the officers who execute the writs issuing from the superior courts in Scotland. The duty of executing these appears to have rested with the Lyon King at Arms, aided by the heralds or other assistants. To this day the court of the Lord Lyon has authority to admit to the office of messenger at arms, and to dismiss a messenger for misconduct. Each messenger must find security for the proper performance of his official duties. Messengers require to perform their functions with great precision, as they are not only amenable to questions regarding the liberty of the subject, but have often to perform acts, on the legal accuracy of which the title to landed property may afterwards depend.

MESSENGERS, KING'S, or QUEEN'S, certain officers employed under the secretaries of state, who are kept in readiness to carry despatches both at home and abroad. They are not now employed so often as formerly in serving the secretaries' warrants for the apprehension of persons for high-treason or other grave offences against the state. Formerly too it was not unusual for them to keep the prisoners they apprehended at their own houses. A remarkable instance of this practice is detailed in the 'Post-Boy' newspaper of 1713. "London, Jan. 10.—Yesterday morning the Morocco ambassador was taken into the custody of one of her majesty's messengers, by way of reprisal for his master's ordering and committing to slavery several of her majesty's subjects." In the same paper, July 14, 1713, we read, "The emperor of Morocco having released those of her majesty's subjects that had been carried into slavery Don Bentura de Zari, his ambassador, who was in custody of Mr. Chapman, the messenger, by way of reprisal, was on Saturday last set at liberty." So that his excellency must have passed six months in the messenger's custody.

MESSIAH (מָשִׁיחַ) is a Hebrew word, of the same signification as the Greek Χριστός (Christ), *anointed.* In the Old Testament the word is repeatedly applied to persons who were consecrated to the service of God in some sacred office. Thus the Jewish priests, prophets, and kings are called *anointed* (Messiah), or *the anointed of God.* From this general meaning the word has passed into a particular use, referring to the illustrious personage whom the ancient Jews expected, and whom their descendants still expect, to confer some signal blessings on their nation and the world. The word is found in this sense twice in the Old Testament, in Psalm ii. 2, and in Daniel, ix. 25, 26.

The expectation of the Messiah, first excited by the promise given to Eve after the fall of man (Genesis, iii. 15), may be traced from the exclamation of Eve at the birth of Cain, "I have gotten a man from Jehovah," or "a man Jehovah" (Genesis, iv. 1), down through the patriarchal history, the Mosaic law, and the whole series of the Jewish prophets; and it is very generally admitted that remnants of the early belief upon this subject are plainly seen in the religion and traditions of nearly all heathen nations. For information on these traditions, see Dr. J. P. Smith's 'Scripture Testimony to the Messiah,' book ii., c. 2; and Bp. Horsley's 'Dissertation on the Prophecies of the Messiah, dispersed among the Heathen.' See also Hengstenberg's 'Christologie des Alten Testaments.'

The expectations of the Messiah among the Jews in the period between the close of the Old Testament and the birth of Christ, as indicated by the Targums, the Apocrypha, the Book of Enoch, and the writings of Philo and Josephus, were confused and often inconsistent. From Josephus we learn nothing on the subject, a fact sufficiently accounted for by his own temporising disposition and the circumstances in which he was placed.

At the time of Christ's advent various expectations respecting the Messiah prevailed among the Jews. It is sufficiently evident from the New Testament, that, while some looked for a human prince who was to deliver them from the Roman yoke and exalt them to national supremacy, others expected a divine teacher who was to confer spiritual blessings not only upon them but also on the Gentiles. (Bertholdt's 'Christologia Judaeorum Jesu Apostolorumque Aetate,' and Kuinoel's 'Comment. in Lib. Hist. N. T.,' Proleg. ad Johan., § 7.) The opinion of the Samaritans, recorded in John, iv. 42, that the Messiah would be a religious teacher and "the Saviour of the world," is worthy of special attention, because the Samaritans received no part of the Scriptures but the Pentateuch, and were cut off from all intercourse with the Jews by national hatred.

It is the belief of all Christians that Jesus Christ is the Messiah predicted in the Old Testament. The evidence of this fact is contained in the New Testament, especially in the four gospels, from which it appears that his lineal descent, the place, time, and other circumstances of his birth, the constitution of his person, the history of his life and death, the miracles he performed, and the doctrines he taught, all agree to the minutest particular with the prophecies respecting the Messiah.

The Jews, having rejected the claims of Jesus Christ, are still looking for the Messiah, whom they almost universally expect to be a mere man and to confer on them only temporal blessings. Most of the Rabbinical writers of the middle ages speak of two Messiahs: one, the son of David, the conquering monarch; the other, the suffering Messiah, the son of Joseph, who is to fall in battle, fighting for his countrymen against Gog and Magog, and in this sense to die for them. This opinion may be traced up to the 6th century, and perhaps higher. In these Rabbinical writings, especially in the book 'Zohar,' there are scattered valuable fragments of the more ancient belief of the Jewish people on this subject. (Schöttgenii, 'Horæ Hebraicæ et Talmudicæ;' and Lightfoot's 'Works.')

In different ages there have appeared numerous "false Messiahs" (Matt., xxiv. 24). Of these ecclesiastical historians reckon twenty-four, for an account of whom the reader is referred to Johannes à Lent's 'History of False Messiahs.'

MET; META. Prefixes used in chemical nomenclature, to designate compounds closely related to the bodies before the names of which they are placed. Such bodies will generally be found described under the names *minus* the prefix; thus *metanaphthalin* will be noticed under *naphthalin.*

METACENTRE is a point in a floating body, the position of which, relative to that of the centre of gravity, determines the conditions for the stability or instability of the equilibrium of that body. The equilibrium is *stable,* if, when the body receives a slight disturbance from its position, it tends, by the combined action of its own weight and the pressure of the fluid in which it is partially immersed, to re-adjust itself in that position after some oscillations; and the equilibrium is *instable* if a slight disturbance will cause the body to overset and acquire a different position, which will then necessarily be one of stable equilibrium.

The surface of a heavy fluid at rest is a horizontal plane; the portion of this plane which we may imagine to be within the floating body is called the *plane of floatation.*

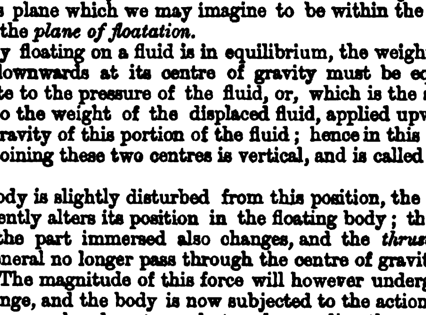
When a body floating on a fluid is in equilibrium, the weight of the body applied downwards at its centre of gravity must be equal and exactly opposite to the pressure of the fluid, or, which is the same, to a force equal to the weight of the displaced fluid, applied upwards at the centre of gravity of this portion of the fluid; hence in this position the right line joining these two centres is vertical, and is called the *line of support.*

When the body is slightly disturbed from this position, the plane of floatation evidently alters its position in the floating body; the centre of gravity of the part immersed also changes, and the *thrust* of the fluid will in general no longer pass through the centre of gravity of the whole body. The magnitude of this force will however undergo but a very small change, and the body is now subjected to the action of two forces which are equal and contrary, but no longer directly opposite.

The figure and density of a body may however possibly be such that the thrust of the fluid may, after the disturbance, continue to pass through the centre of gravity of the body. The equilibrium is then said to be *indifferent,* inasmuch as the disturbance communicated only produces a new position of equilibrium. This happens when a body floats in a fluid of equal density with itself, and in other cases, as in a floating sphere. We may observe that if the disturbance of the equilibrium consisted merely of an elevation or depression of the centre of gravity, small vertical oscillations would be the consequence: the disturbance considered here is supposed such as to tend to turn the body *round* its centre of gravity, or to make the original line of support deviate in a vertical plane through a very small angle; this line is called the *axis* passing through the centre of gravity.

When the position of the body is thus disturbed, if the line of thrust when produced upwards meets the above-named axis, the point of intersection is called the *metacentre.* The consequent motion of the body will then be the same as if the centre of gravity were fixed, and

Fig. 1.



the thrust applied vertically at the metacentre; hence if the metacentre be *above* the centre of gravity, the thrust tends to re-adjust the axis, and the equilibrium is stable; if *below*, that force tends to carry the axis farther from its original place, and the equilibrium is instable: if the two centres coincide, the equilibrium is indifferent. We give an example:—

Fig. 1. ABCD is a vertical *square* section passing through G, the centre of gravity of a rectangular beam floating on a fluid of twice its specific gravity, this section being at right angles to the faces of the beam; therefore $GH = \frac{1}{2}AB$; and if $gH = \frac{1}{4}AB$, g is the centre of gravity of the fluid displaced, Gg is the line of support, and EF the plane of floatation.

Fig. 2.

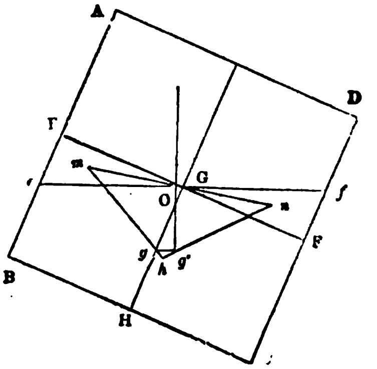


Fig. 2 represents the same body turned round its centre of gravity through a small angle FGf or θ. Let $GF = 1$; we must find g', the centre of gravity of $efCB$, and draw $g'O$ vertical or perpendicular to ef, cutting the axis GH in O the metacentre. Let m, n, be the centres of gravity of the portions EGe, FGf, and h that of the portion $eGFCB$, then $hg : gm ::$ solid EGe : solid $eGFCB$; and $hg' : g'n ::$ solid FGf : solid $eGFCB$; but the solids EGe, FGf, are equal: hence $hg : gm :: hg' : g'n$, therefore gg' is parallel to mn, or nearly horizontal, and $= mn, \frac{\text{solid } EGe}{\text{solid } EFCB}$ nearly. Now $mn = 2Gm = \frac{4}{3}$, and solid $EGe = \frac{1}{2}\theta \times$ length, solid $EFCB = 2 \times$ length; therefore $gg' = \frac{4}{3} \times \frac{1}{4} \times \theta = \frac{\theta}{3}$: but $\angle\, gOg' = \theta$; therefore $gO = \frac{1}{3}$, or $GO = \frac{GH}{6}$: hence the equilibrium is instable. If the equilibrium were stable, the times of the oscillations would be found by supposing the thrust applied at O, the point G remaining fixed.

METACETAMINE. [PROPYLAMINE.]

METACETIC ACID. [PROPIONIC ACID.]

METACETONE ($C_{12}H_{10}O_2$). When a mixture of 1 part of sugar and 8 parts of lime is submitted to distillation, the temperature, after reaching 284° Fahr., rapidly rises, and a very small quantity of combustible gas is liberated, accompanied with a liquor which is a mixture of acetone and metacetone. When water is added the metacetone separates, which is to be rectified, the last portions of the product being preserved.

Metacetone is a colourless liquid of an agreeable odour. It boils at about 153° Fahr.; does not mix with water, but combines with alcohol and ether. It is not improbable that metacetone is identical with propione, a body which stands in the same relation to propionic acid as acetone does to acetic acid.

METACETONIC ACID. [PROPIONIC ACID.]

METACETONITRYL. [PROPYL, *Cyanide of.*]

METACINNAMEIN. A modification of Styracin. [STYRACIN.]

METAFURFUROL. A very oxidisable oil accompanying furfurol.

METAGALLIC ACID ($C_{24}H_8O_8$); *Gallulmic Acid*; is prepared by the partial decomposition of gallic acid by quickly heating it up to about 480° Fahr. Carbonic acid and water are formed and separated, and a black, shining, tasteless compound is left, which is not dissolved by water, but is easily taken up by the alkalies ammonia, potash, and soda in solution. It also decomposes the solutions of the alkaline carbonates, expelling the carbonic acid. Metagallate of potash gives insoluble precipitates with the salts of baryta and strontia, and also with many metallic salts. [GALLIC ACID.]

METALDEHYDE. [OTHYL, HYDRIDE OF.]

METALLURGY is the art of separating metals from their ores. The processes vary for every metal, and are described under each.

METALS. The great characteristic of these well known substances is their lustrous appearance; it is indeed so constant an accompaniment of them as to afford, under the name of *metallic lustre*, a standard of description for the appearance of other bodies.

Metals, in the common acceptation of the term, are either compound or simple. Brass, bronze, britannia metal, &c., are examples of compound metals; that is, they are composed of two or more simple metals. Compound metals are, however, always distinguished as ALLOYS, and hence the word metal is correctly, though not invariably, applied only to the simple or elemental metals.

The metals or metallic elements are considerably greater in number than the non-metallic elementary bodies, or metalloids. Including one or two concerning whose metallic character there is a little doubt, the whole number is about forty-nine. Very few of them occur naturally in the free or uncombined state, being generally associated with non-metallic elements, constituting *ores*. Some of them are obtained with such difficulty that they are very rarely met with, existing only in the cabinets of the curious, or perhaps exclusively met with in the laboratories of the chemists who succeeded in isolating them. Several of them, however, such as gold, silver, copper, iron, lead, tin, and mercury, have been known from the most remote ages, and nearly all the rest are well known to chemists.

The physical characters of the metals, including colour, relative lustre, ductility, malleability, tenacity, relative brittleness, hardness, elasticity, sonorousness, structure, power of conducting heat and electricity, melting point, and volatility, have already been described under METALS, in the NATURAL HISTORY DIVISION of this Cyclopædia. Their condition and distribution in nature is also there dwelt upon, and the action of metalloids upon them cursorily noticed. The methods of separating them from each other have been given in the present division of the work, under CHEMICAL ANALYSIS; and it now, therefore, only remains to detail the various methods of classification that convenience or analogy has induced chemists and physicists to adopt.

The following is a useful descriptive method of classification, and is frequently employed in works on chemistry.

1.—Metals of the alkalies:—

Potassium
Sodium
Lithium.

2.—Metals of the alkaline earths:—

Barium
Strontium
Calcium
Magnesium

3.—Metals of the earths:—

Aluminium
Glucinum
Yttrium
Erbium
Terbium
Zirconium
Thorinum
Cerium
Lanthanium
Didymium

4.—Oxidable metals, whose oxides form powerful bases:—

Manganese
Iron
Chromium
Nickel
Cobalt
Copper
Zinc
Cadmium
Bismuth
Lead
Uranium

5.—Oxidable metals, whose oxides form weak bases or acids:—

Vanadium
Tungsten
Molybdenum
Tantalum
Niobium
Pelopium ?
Ilmenium ?
Titanium
Tin
Antimony
Arsenic
Tellurium
Osmium

6.—Metals whose oxides are reduced by heat. Noble metals:—

Gold
Mercury
Silver
Platinum
Palladium
Iridium
Ruthenium
Rhodium

Analytical Classification of the Metals.

Group I.

Potassium
Sodium
Lithium

Group II.

Barium
Strontium
Calcium
Magnesium

Group III.

Aluminium
Chromium
Glucinum
Thorinum
Yttrium
Zirconium
Erbium
Terbium
Cerium
Didymium
Lanthanium

Group IV.

Iron
Manganese
Cobalt
Nickel
Zinc
Uranium

Group V.

Gold
Platinum
Iridium
Tin
Arsenic
Antimony
Molybdenum

Group VI.

Lead
Silver
Mercury
Cadmium
Copper
Bismuth
Osmium
Palladium
Rhodium
Ruthenium

The following arrangement, founded upon the relative power of the metals to decompose water and the action of heat upon their oxides, is known as

Thénard's Classification of the Metals.

CLASS 1.—Metals which decompose water with brisk effervescence at 32° Fahr.:—

Potassium
Sodium
Lithium
Barium
Strontium
Calcium

Class 2.—Metals which do not decompose water under 212°, but far below a red heat:—

Aluminium
Glucinum
Thorinum
Yttrium
Zirconium
Lanthanium
Cerium
Manganese
Magnesium

Class 3.—Metals which do not decompose water except at a red heat, or at common temperatures in contact with strong acids:—

Iron
Nickel
Cobalt
Zinc
Cadmium
Tin
Chromium
Vanadium

Class 4.—Metals which decompose water at a red heat, but not at common temperatures, even in contact with strong acids:—

Tungsten
Molybdenum
Osmium
Tantalum
Titanium
Arsenic
Antimony
Tellurium
Uranium

Class 5.—Metals which do not decompose water even at a red heat, and whose oxides are not reduced by heat alone:—

Copper
Lead
Bismuth

Class 6.—Metals which do not decompose water under any circumstances, but whose oxides are reduced by heat:—

Silver
Mercury
Gold
Palladium
Platinum
Rhodium
Iridium

The special characters of the metals; their farther relation to, and action upon, one another; the action of metalloids, acids, &c., upon them individually; and the formation, properties, use, &c., of their compounds, will be found described under their respective names, with the exception of iron, which we shall now proceed to describe.

Iron (Fe). In combination with other bodies, iron is perhaps more widely diffused than any of the metals. It is found in the ashes of nearly all plants, is a constant constituent of the blood of the vertebrate animals, and although only a few of its ores are economically made use of, they are more numerous than those of any other of the heavy metals. [Iron, in Nat. Hist. Div.] The range of affinities of iron is so great that it is very rarely met with in the uncombined state, and it is only with considerable difficulty that it can be artificially obtained in an absolutely pure condition. The process recommended by Berzelius for preparing chemically pure iron consists in heating filings of the best bar iron with pure oxide of iron under a layer of powdered green glass in a Hessian crucible: the whole being subjected to the highest temperature of a smith's forge, the filings are deprived of their carbon and silicon by the oxide, and fusing together collect at the bottom of the crucible in a button possessing silver-like lustre and whiteness. Iron thus prepared has a specific gravity of 7·8439, and is very tough and much softer than the ordinary metal. Another method of procuring perfectly pure iron is by passing a current of hydrogen gas over pure peroxide of iron, heated carefully to redness: if the temperature is too low the resulting product inflames spontaneously on coming in contact with the air, but when prepared at a higher temperature may be kept unaltered; in this state it is sometimes used in medicine, under the name of *Quevennes iron, Fer reduit*, or *Pulvis ferri*.

Pig, cast, malleable, and *rolled* iron are the ordinary states of the metal met with in commerce; their manufacture and properties have already been described. [Iron Manufacture and Trade.] In one or more of these conditions iron has been known from the most remote period. Cutting instruments made of this metal are mentioned in the books of Moses. The method of reducing and forging iron is described in Homer and Hesiod, and Pliny's 'Natural History' contains a long article on the subject. The alchymists considered it to be a compound of gold and the hypothetical body acrimony, and symbolised it therefore by the sign ♂; they gave it the name of *Mars*, probably because weapons made of it were used in the service of the god of war.

Iron has a white or grayish white colour. When tolerably pure, as in bar-iron, it is very difficult of fusion, but at a white heat possesses the valuable property of welding; that is, two pieces brought into contact at that temperature, and well pressed together by hammering, unite as perfectly as if they had been joined by melting. The heat of the oxyhydrogen blowpipe or of the voltaic arc, however, is sufficient to even volatilise iron. Iron can be beaten out into tolerably thin sheets, but is not nearly so malleable as gold or silver. It is very ductile, being capable of being drawn into thinner wire than that of any other metal. In tenacity also it is unsurpassed, a wire of one thirty-sixth of an inch in diameter sustaining a weight of sixty pounds before breaking. Iron readily conducts heat and electricity, but is inferior in these respects to some other metals. It is attracted by the magnet, and may itself be rendered permanently magnetic; the latter property is destroyed on heating the metal to redness, but is recovered again on cooling.

Under the influence of air and moisture iron rapidly attracts oxygen, or *rusts*, especially after the first spot has been produced. The exact action that goes on is not very well made out; it appears probable that the peroxide first formed is reduced to the state of protoxide by the particles of the metal with which it is immediately in contact, the protoxide so produced absorbing oxygen from the air and being re-converted into peroxide; in short, that the peroxide of iron protoxidises the metal and that the air peroxidises the protoxide. The carbonic acid present in the air also plays an important part in the rusting of iron. This liability of iron to rust is perfectly prevented by keeping it dry; but the object is most commonly effected by constant removal of the surface of oxide by polishing powders, such as emery or brick-dust, or by enveloping the metal in a covering of plumbago, a mechanical process known in domestic life as *blackleading*.

Iron decomposes water at a red heat, hydrogen being evolved, and a black oxide of iron produced. Diluted sulphuric, hydrochloric, nitric, and other acids dissolve iron, with evolution of hydrogen or, in the case of nitric acid, of binoxide of nitrogen. Strong nitric acid, however, does not act upon iron, the metal remaining in what is termed the *passive condition*, a condition that seems to be intimately connected with the electrical relations of this metal.

Wrought iron, steel, and *cast iron* differ from each other chemically chiefly in the amount of carbon they contain. Thus wrought iron contains only from about 0·2 to 0·4 per cent.; steel, from 1·3 to 1·5; while cast-iron sometimes contains as much as 5·0 per cent. of carbon. From recent researches it appears that to the presence of a greater or smaller quantity of titanium is owing the value of iron used for making steel, and that titanium moreover confers other important properties on iron. Iron also sometimes contains silicon, sulphur, phosphorus, arsenic, and traces of other metals, such as aluminium, calcium, potassium, manganese, &c., but these deteriorate its quality.

The combining equivalent of iron is 28, and its symbol (Fe), (from *ferrum*, Lat.). It unites with other elements and compounds, chiefly in two proportions, forming respectively *protosalts* and *persalts*. In the former the constituents are equal in number; in the latter, two equivalents of iron are associated with three of the other body, and for that reason are sometimes called *sesquisalts*.

Iron and *oxygen* form three definite compounds:—

1. Protoxide of iron	FeO
2. Peroxide of iron	Fe_2O_3
3. Ferric acid	FeO_3

A fourth is also sometimes described, it contains Fe_3O_4, and is termed the *black* or *magnetic oxide*, but it does not form salts, and may be viewed as a combination of one equivalent of protoxide with one of peroxide ($FeO + Fe_2O_3 = Fe_3O_4$). It is in fact formed by precipitating a solution of equivalent quantities of a proto and per-salt by an alkali. The natural form of this oxide is the well-known mineral *loadstone*, and is the valuable ore from which Swedish iron is smelted.

1. *Protoxide of iron* (*ferrous oxide*) (FeO). This body, though a very powerful base, and forming, with acids, a well-marked class of compounds called salts of protoxide of iron, is nevertheless not known in the separate state, so readily does it take up oxygen and form peroxide. In the hydrated state (FeO,HO) it is precipitated in white flocks on adding an alkali to a solution of a protosalt of iron. If care is not taken to exclude every trace of air from the liquid used in its preparation it is contaminated with more or less peroxide, and then falls down as a light green or blue precipitate. In contact with air it gradually becomes entirely converted into red peroxide.

2. *Peroxide of iron* (*sesquioxide* or *ferric oxide*) (Fe_2O_3). This oxide occurs native as *hæmatite, specular iron ore*, &c. [Iron, in Nat. Hist. Div.] It is artificially prepared by heating the hydrate, or by igniting the protosulphate. Under the names of *colcothar, crocus of Mars, rouge*, &c., it is largely used as a pigment, and for polishing glass and jewellery. The *hydrated oxide* ($Fe_2O_3\ x\,HO$) is best prepared by precipitating a solution of the perchloride or persulphate with ammonia, well washing and gently heating. When first precipitated this hydrate is very flocculent and bulky, but contracts remarkably on drying. It has a dull red colour, not nearly so bright as the anhydrous oxide. It forms salts with acids, but is a weaker base than the protoxide.

Hydrated peroxide of iron is now largely used for the purification of coal-gas. [Gas-Lighting.]

3. *Ferric acid* (FeO_3) is not known in the free state. Combined with potash it is obtained on heating to bright redness peroxide of iron with four times its weight of nitrate of potash. It is very soluble in water, forming a dark violet solution. Other *ferrates* are produced by double decomposition; they are all uncrystallisable and very unstable, readily yielding up their oxygen, especially to organic matter.

Iron and *sulphur* combine in several proportions. The two most important sulphides are:—

1. Protosulphide of iron	FeS
2. Bisulphide of iron	FeS_2

1. *Protosulphide of iron* (FeS) is a bye-product in certain metallurgic operations with copper. It is of little value, being chiefly employed in chemical laboratories for the generation of sulphuretted hydrogen. For this purpose it is sometimes prepared by fusing together equivalent proportions of iron (filings) and sulphur, or better, by rubbing rolls of sulphur on a bar of iron heated to whiteness in a smith's forge, the liquid sulphide being allowed to flow down into cold water.

2. *Bisulphide of iron* (FeS_2) (*iron pyrites*) occurs native in beautiful brass-yellow crystalline masses. It is valueless as a source of metal,

but under the name of *mundic* is extensively used as a source of sulphur in the manufacture of sulphuric acid. Some varieties of it decompose when exposed to air, being gradually converted into sulphate of iron. [ALUM.]

The *phosphides of iron* are unimportant.

Iron and *chlorine* form two compounds:—

1. Protochloride of iron . . . . . . $FeCl$
2. Perchloride of iron . . . . . . Fe_2Cl_3

1. *Protochloride of iron* in the anhydrous state ($FeCl$) is obtained on passing dry hydrochloric acid gas over iron filings heated to redness, hydrogen is evolved, and the salt sublimes in white micaceous scales. In the hydrated condition it may be prepared by dissolving iron in hydrochloric acid, and evaporating in vacuo; green crystals are then produced ($FeCl + 4$ Aq.), which must be preserved in an atmosphere of hydrogen or of carbonic acid.

Other metals may be coated with iron by boiling them in a solution of protochloride of iron containing chloride of ammonium and pieces of zinc.

2. *Perchloride of iron* (Fe_2Cl_3) (*sesquichloride*). Obtained in brown scales on passing excess of chlorine over iron heated to redness. It sublimes at a red heat, is soluble in alcohol or ether, and is very deliquescent. The *hydrated perchloride* is deposited in large red crystals on evaporating a solution of the hydrated peroxide in hydrochloric acid. They contain six equivalents of water of crystallisation. Solution of perchloride of iron has a great tendency to dissolve peroxide, and on evaporation the solution yields a confusedly crystalline mass of uncertain composition. The following is a convenient method of preparing a definite solution of perchloride of iron. Five parts of iron filings are dissolved in twenty parts of the common strong hydrochloric acid, the liquid filtered through asbestos, three additional parts of the acid then poured in, and the whole heated to ebullition; nitric acid is now gradually added till no more red fumes are evolved, when the iron will all be in the state of perchloride. If necessary, the solution may be evaporated to the crystallising point; if carefully prepared it will contain no free acid.

Solution of perchloride of iron mixed with alcohol forms the *tincture of sesquichloride of iron* used in medicine.

Iron and *iodine*,

Iron and *bromine*, and

Iron and *fluorine* form combinations corresponding to the two chlorides. The only one of importance is the

Protoiodide of iron (FeI). This salt is used in medicine, and is prepared by boiling iodine with excess of iron filings, or small nails, in water. On evaporation, the solution yields green crystals, containing $FeI + 4$Aq. These crystals fuse on the application of a moderate heat, give off their water of crystallisation, and on cooling solidify into a steel-grey crystalline mass. In manipulating with iodide of iron, contact of air should be avoided as much as possible, as an oxyiodide is very apt to form; the operations should also be conducted in iron vessels, and when in solution a piece of iron wire should be immersed in the liquid.

Protocarbonate of iron (FeO, CO_2) occurs native. It is from this ore that most of the English iron is obtained. [IRON, in NAT. HIST. DIV.] It also exists, dissolved by the aid of carbonic acid, in certain natural waters or chalybeate springs. It may be formed artificially by precipitating a protosalt of iron with an alkaline carbonate: at first it is white, but rapidly loses carbonic acid, absorbs oxygen from the air, becomes green, black, and finally red (peroxide of iron). This change may be considerably retarded by mixing it while moist with powdered white sugar, and rapidly drying over a water-bath; it then constitutes the *carbonate of iron with sugar* of the London Pharmacopœia.

Phosphates of iron are numerous, but ill defined. The principal are these:—

1. Phosphate of protoxide of iron.
2. Phosphate of peroxide of iron.
3. Pyrophosphate of peroxide of iron.

1. *Phosphate of protoxide of iron*, or *protophosphate of iron* ($2FeO, HO, PO_5$, or $3FeO, PO_5$). This is obtained as a white precipitate on adding ordinary tribasic phosphate of soda to protosulphate of iron. It is insoluble in water, but soluble in solution of phosphoric acid, and the latter liquid, when mixed with sugar, constitutes the *syrup of phosphate* (or *superphosphate*) *of iron* used in medicine.

2. *Phosphate of peroxide of iron*, or *perphosphate of iron* ($Fe_2O_3, PO_5 + 4$Aq.), falls as a white precipitate on mixing solutions of a persalt of iron and ordinary tribasic phosphate of soda. Unlike the protophosphate, it does not absorb oxygen from the air, and, being of constant composition, is frequently used in quantitative analysis as a means of estimating phosphoric acid. It is insoluble in acetic acid, but soluble in solution of peracetate of iron.

3. *Pyrophosphate of peroxide of iron* (*pyrophosphate of iron*), ($2Fe_2O_3, 3PO_5 + 9$Aq.), a white powder produced by double decomposition of a persalt of iron with dibasic phosphate (or pyrophosphate) of soda. It is insoluble in water or in dilute acids, but soluble in alkaline pyrophosphates or citrates, such solutions yielding, when evaporated to a syrup and spread over glass plates, beautiful transparent scales of yellowish-green or red colour. They are used in medicine under various names, the *citro-ammoniacal-pyrophosphate of iron and soda* being one of them.

Sulphates of iron are two:—

1. Protosulphate of iron.
2. Persulphate of iron.

1. *Protosulphate of iron. Green vitriol. Copperas.* ($FeO, SO_3 + 7$Aq.) This salt is largely produced in the manufacture of ALUM. It is also formed in the process for precipitating copper from the solution of sulphate of copper obtained in certain metallurgical operations with that metal. Old scrap iron is used for this purpose, and, replacing the copper in solution, is obtained as sulphate of iron on evaporating the liquor. Sulphate of iron may be formed on the small scale by dissolving iron in dilute sulphuric acid. The following decomposition takes place:—

$$\underbrace{Fe}_{\text{Iron.}} + \underbrace{HO, SO_3}_{\text{Sulphuric acid.}} = \underbrace{FeO, SO_3}_{\substack{\text{Sulphate of}\\ \text{iron.}}} + \underbrace{H}_{\text{Hydrogen.}}$$

On evaporating the solution the salt crystallises out in beautiful bluish-green rhomboidal crystals. These, however, like all the protosalts of iron, must be exposed as little as possible to the air, for they quickly absorb oxygen, and a separation into basic and neutral persalts results, thus:—

$$\underbrace{4FeO, SO_3}_{\substack{\text{Protosulphate}\\ \text{of iron.}}} + \underbrace{O_2}_{\text{Oxygen.}} = \underbrace{Fe_2O_3, SO_3}_{\substack{\text{Subsulphate}\\ \text{of iron.}}} + \underbrace{Fe_2O_3, 3SO_3}_{\substack{\text{Persulphate}\\ \text{of iron.}}}$$

Subsulphates of other composition are also frequently produced.

Protosulphate of iron is insoluble in alcohol, soluble in twice its weight of cold water, but much more so in hot water. When heated it loses six equivalents of its water of crystallisation, at a red heat is decomposed into sulphurous and sulphuric acids, which escape, while peroxide of iron (colcothar) remains. It is largely used in black DYEING and in the manufacture of writing INK.

2. *Persulphate of iron* ($Fe_2O_3, 3SO_3$). Five parts of crystals of protosulphate are dissolved in water, one part of sulphuric acid added, and nitric acid poured into the hot solution till no more black colour is produced. Abundance of nitrous vapours are evolved, and the yellow solution, on evaporation to dryness, yields a buff-coloured mass of persulphate of iron, having the above composition.

This salt occurs native. [IRON, *Coquimbite*, in NAT. HIST. DIV.]

Potassio-sulphate of iron ($Fe_2O_3, 3SO_3 + KO, SO_3 + 24$Aq.) is a double salt containing persulphate of iron and sulphate of potash. Corresponding salts with the other alkaline sulphates may also be formed. They all crystallise, and, being isomorphous with common alum, are frequently, though erroneously, called *iron alums*. They are formed by the spontaneous evaporation of mixed solutions of the salts, are to some extent used in medicine, but are liable to decompose.

The *iodate, bromate*, and *perchlorate of iron* are indefinite, unimportant salts.

Nitrates of iron.—The *protonitrate* (FeO, NO_5) is formed when cold nitric acid is saturated with protosulphide of iron: on evaporating the solution in vacuo, the salt crystallises out in pale green crystals containing seven atoms of water. The crystals are very deliquescent, and unstable. The *pernitrate* is produced when metallic iron is dissolved in strong nitric acid. It is very difficult to crystallise, the solution on evaporation depositing a basic salt. Solution of pernitrate of iron is used in dyeing.

Silicates of iron. Many of these occur native. [IRON, in NAT. HIST. DIV.]

Arsenites and arsenates of iron. In cases of poisoning by arsenic, the best antidote to administer is freshly precipitated peroxide of iron mixed with a little hydrate of magnesia. The efficiency of this antidote depends upon the formation of perarsenite of iron, which is an insoluble compound; that is, insoluble in water, but not altogether insoluble in the liquids of the stomach, which usually contain traces of hydrochloric, acetic, and lactic acids: the solution may, however, be prevented by mixing the oxide with magnesia, which neutralises those acids in a far more effectual manner than excess of peroxide of iron would do.

Acetates of iron. [ACETATE.]

Gallates and *tannates of iron.* [INK: *Writing Ink.*]

Citrates of iron. A double citrate of iron and ammonia is obtained when freshly precipitated protoxide of iron is dissolved in citric acid and excess of ammonia added. The compound does not crystallise; but when the solution is evaporated to the consistence of syrup and spread over glass plates it dries up and forms brilliant transparent scales of garnet-red colour.

Citrate of iron and quinine is a medicinal agent of some repute. It is prepared by dissolving together three parts of citrate of iron and one of citrate of quinine, and scaling as just described. The citrate of iron is made by saturating citric acid with moist peroxide of iron, evaporating and scaling; and the citrate of quinine by double decomposition of sulphate of quinine and citrate of soda.

Tartrate of iron. A double compound of tartrate of iron and potash, of somewhat similar physical properties to the last preparations, but darker in colour, may be formed by dissolving moist, recently precipitated peroxide of iron in a hot solution of bitartrate of potash. This compound is also used in medicine.

Alloys of iron are numerous, but only two are important, namely, those with tin and with zinc. The former will be found described under TIN (*tin-plate*); the latter is produced when sheets of iron, cleaned as perfectly as if required for tin-plate, are dipped into a bath of melted zinc, on the surface of which is a stratum of sal ammoniac. The surface of the iron then becomes alloyed with zinc, and is thus preserved from oxidation by the air when employed in exposed situations. Moreover articles made of *galvanised iron,* as this zinc plate is commonly called, are easily soldered together, which is not the case with sheet-iron alone.

Tests for iron. Solutions of the *protosalts* yield greenish or bluish-white precipitates with the alkalies, or their carbonates; none with sulphuretted hydrogen; black with sulphide of ammonium; dark blue with *red* prussiate of potash; and light blue with the *yellow* prussiate of potash.

Solutions of the *persalts* give red-brown precipitates with the alkalies or their carbonates; are reduced to the state of protosalts by sulphuretted hydrogen, a light yellow precipitate of sulphur occurring at the same time; are precipitated black by sulphide of ammonium; dark blue by the *yellow* prussiate of potash, and not at all by the *red* prussiate of potash. Exceedingly small quantities of iron may also be detected in solution by the sulphocyanide of potassium, which gives a red liquid, and by tincture of galls which produces a black colour (ink).

In the *quantitative estimation of iron* the metal is always weighed in the form of peroxide. The definite state of the latter is ensured first by boiling the solution with nitric acid in order that the iron may be completely peroxidised, and second by precipitating with ammonia, because any trace of the salts of that alkali may be readily expelled by igniting the well washed precipitate. The resulting red oxide of iron is pure sesquioxide ($Fe_2 O_3$), and contains, in one hundred parts, seventy of iron (Fe) and thirty of oxygen (O).

Ferrocyanogen (Fcy or $Cfy = FeCy_3$) is a bibasic radical which has not been isolated, but which is assumed to exist in certain familiar chemical compounds. With two equivalents of hydrogen it forms FERROCYANIC ACID ($H_2 Cfy$), and with two of metal a class of salts called *ferrocyanides,* of which ferrocyanide of potassium ($K_2 Cfy$) is a type.

Ferridcyanogen ($Fcdy$ or $Cfdy = Fe_2Cy_6$) is a similar radical, but tribasic. With three equivalents of hydrogen it forms FERRIDCYANIC ACID ($H_3 Fcdy$), and with three of metal, a class of salts called *ferridcyanides,* of which ferridcyanide of potassium ($K_3 Fcdy$) is the type.

Prussian blue is a variable mixture of the ferro- and ferrid-cyanides of iron. [BLUE: *prussian blue.*]

METAMARGARIC ACID. An acid of the same composition as margaric acid. Its existence has not been satisfactorily established. [MARGARIC ACID.]

METAMECONIC ACID. [MECONIC ACID.]

METAMERIC COMPOUNDS. [ISOMERISM.]

METAMERIDES. Chemical compounds which have the same combining proportion, but which differ in constitution and properties.

METAOLEIC ACID. [OLEIC ACID.]

METAPECTIC ACID. [PECTIC ACID.]

METAPHOR (*μεταφορά*, literally 'a transference'), a figure of speech which renders the subject of discourse striking, by the aid of expressions primarily referring to other objects. A common kind of metaphor is that called personification, where inanimate beings are represented as endowed with life, and even with feeling, reason, &c., as "the fields do laugh and sing,"—"stern winter." If this kind of metaphor spiritualises the corporeal, another kind, on the contrary, embodies the spiritual, as "the star of renown"—"the pinnacle of honour," and so on. A third kind is little else than a shortened simile, two objects in the same sphere being brought together, only on account of their resemblance. To this kind belong such expressions as "the silver moon"—"the golden sun," &c., where it will be seen at once that "silver" and "moon," gold" and "sun," are connected merely on account of their obvious similarity of colour and brightness. The origin of the first two kinds of metaphor is not so apparent, for though they likewise express a similarity, yet the similarity of a series of bodily objects to a series of objects merely of the mind, where there can of necessity be no sensible resemblance, is a subject for psychological investigation. The application of certain metaphors, in all languages and among all people, attracted the attention of Jean Paul Richter, who remarked that, "no nation called error, light, or truth, darkness." If we attend to the state of language, we shall find that a great part of the commonest discourse is composed of metaphors of the second kind, and that nearly all words expressing mental states, operations, and affections are in fact metaphorical. Thus, we say every day "a man of extended views"—"a man of good capacity, acute judgment," &c., where the words "extended," "views," "capacity," "acute," evidently belonged originally to material objects, but have been applied to things immaterial by metaphors. The circumstance that material objects are more apparent, that language seems primarily to have them for its sole objects, and that when a higher degree of reflection brings with it objects belonging to the mind alone, nothing is left but to apply in a new sense the words already formed, is sufficient to explain the use of these metaphors generally. But still the fact that such and such bodily attributes are universally predicated of such and such spiritual objects alone, may still furnish matter for consideration to the curious in psychological speculation.

METAPHYSICS, a name originally applied to those books of Aristotle which followed his 'Physics,' and which his editors called 'the books after the Physics' (*μετὰ τὰ φυσικά*). In modern times the word has been variously applied, and seems to assume quite a distinct meaning as employed by different authors. With the Germans, metaphysics is a science purely speculative, which soars beyond the bounds of experience. The objects of this science are supersensual ideas, unattainable by experience, and the difficulty of defining the word lies in the circumstance that the very knowledge of the ideas sought requires some proficiency in the study. Hence to one altogether unacquainted with speculative philosophy it is almost impossible to explain the meaning of the word "metaphysics" as used in this sense. The very possibility of a science beyond experience has been denied by a great number of philosophers, and many works called metaphysical should rather be termed inquiries into the possibility of metaphysics. Thus Kant's celebrated work, the '*Kritik der reinen Vernunft,*' is a mere inquiry into the possibility of a theoretical science of things beyond experience, which terminates with a denial of such possibility; and hence some modern philosophers have considered Kant as no metaphysician, but as a critic of the mental faculties, whose labours were to be the precursors of a new system of speculation. On the other hand, a work like Spinoza's "Ethics" is purely metaphysical. He assumes the possibility of his science, and, proceeding from a number of axioms, speculates accordingly. Those who deny the possibility of metaphysics deny even the right to assume any axioms as applicable to a sphere beyond experience; and those who did assume them, as Spinoza, Liebnitz, and Wolf, were called by the Kantians dogmatists, in opposition to their own appellation of critics. The great point to be established prior to metaphysical speculation is the identity, or at least the necessary concurrence, of thought and being. This once established, speculative inquiry may proceed, as the results of logical investigation must in such a case, of course, concur with the nature of being itself; but the sceptics always deny the right of assuming such identity or concurrence, while on the other hand different theories have been adopted to prove them, such as those of harmony between body and spirit,—of the non-being of body altogether, except as an affection of spirit,—of an absolute identity between thought and being, &c. It may be as well to observe that the critical philosophy, which assumes nothing but the "I" or "ego," and the laws of thought (Fichte deducing even the latter from the axiom, "I am I"), has Descartes for its author, whose "Cogito, ergo sum," lies at the basis of most modern systems. [DESCARTES, in BIOG. DIV.]

In England, the word metaphysics is usually applied to denote the philosophy of mind, as distinguished from that of matter. This science treats of the association of ideas, memory, and various phenomena of mind; and as it consists merely in collecting facts and making inductions like any other experimental science, its possibility is no more questionable than that of chemistry or electricity. However, Locke's 'Essay on the Human Understanding,' as a denial of any source of knowledge other than experience, may be put at the side of Kant's 'Kritik,' as containing inquiries of similar nature, though the results be different; Berkeley's 'Idealism' may be compared with the "Wissenschaftslehre' of Fichte, and the Common-sense theory of Reid with the views of Jacobi. The philosophy of mind as an experimental science has been chiefly treated by the modern Scotch philosophers, among whom the late Sir W. Hamilton holds a high place.

METATARTARIC ACID. [TARTARIC ACID.]

METEMPSYCHOSIS (*μετεμψύχωσις*), derived from a Greek word signifying the passage or transmigration of souls, forms a part of the philosophical or religious belief of many nations. The Hindus believe that the souls of men pass after death into different bodies, either of men or animals, unless an individual has lived a most holy and religious life; in which case his soul is absorbed into the divine essence. "The soul passes from one state to another invested with a subtile frame consisting of elementary particles, the seed or rudiment of a grosser body. Departing from that which it occupied, it ascends to the moon, where, clothed with an aqueous form, it experiences the recompense of its works; and whence it returns to occupy a new body with resulting influence of its former deeds. But he who has attained the true knowledge of God does not pass through the same stages of retreat, but proceeds directly to reunion with the Supreme Being, with which he is identified, as a river at its confluence with the sea merges therein altogether. His vital faculties and the elements of which his body consists are absorbed completely and absolutely; both name and form cease; and he becomes immortal without parts or members."

('Extracts from the *Brahma-sûtras*, or Aphorisms on the Vedanta doctrine, by Bâdarâyana,' translated by Mr. Colebrooke, in 'Trans. of the Roy. As. Soc.,' vol. ii.)

The migration of souls from one body to another also formed, as is well known, a leading feature of the Pythagorean doctrine. This doctrine was also a part of the Egyptian religious system. The Egyptians, says Herodotus (ii. 123), are the first who believed in the immortality of the soul. As soon as the body begins to decay, the soul passes from one animal to another; and when it has passed through the forms of all animals, terrestrial, aquatic, and winged, it again enters a human form. This period of transmigration is completed in 3000 years. Some of the Greeks, he adds, both in early times and more recently, have maintained this doctrine and claimed it as their own; and though he could mention names, he declines to do so.

METEOROLOGY, in its extended sense, embraces all physical causes which affect the state of the atmosphere or are affected by it. Hence it is connected with the phenomena of heat and cold, dew, rain, hail and snow, clouds, winds, auroræ boreales and australes, or polar lights, haloes, parhelia, &c. The sense in which Aristotle (Μετεωρολογικά, i.) uses the term is still more extensive, comprehending, in addition to what are now called meteors, every affection (*πάθος*) common to the air and water, with the characters of the different parts of the earth, and their affections, as winds and earthquakes, and everything incident to such kinds of motion.

Our first inquiry shall be, what is the nature and what the probable extent of the terrestrial atmosphere? Essential as it is both to animal and vegetable life, to the distribution of heat, and to various modifications of light, the knowledge of its nature and composition is eminently useful. The air, though composed of several elastic fluids, obeys the same laws to which they are individually subject, namely, its elasticity and density at a given temperature are proportional to the pressure which it sustains, and for every degree of the centigrade thermometer under a given pressure it expands very nearly $\frac{3}{800}$ of its volume at the temperature zero. Hence if its density be represented by δ and its temperature by t (in centigrade degrees), its elastic force will be proportional to $(1+\alpha t)\cdot\delta$ (where α represents the decimal ·00375) as well as the pressure sustained. Lastly, the pressure is equal to the weight of a vertical column of atmosphere, having the portion pressed on as a base, and extending upwards to its extreme limit.

According to Dalton's views, the various gases constituting the air are not chemically combined by the law of definite proportions, but only mechanically mixed, co-existing in the same space, and producing by the sum of their independent pressures the elevation of the mercury in the barometric tube. In modern chemical physics, they are said to be mingled by the principle of DIFFUSION, which is the form in which Dalton's conception is now held.

We have seen that heat increases the elastic power of air, and hence the equilibrium of a mass of air unequally heated is constantly disturbed. The currents of warm and cold air change places, the cold air moving to the warm region, and thence, when warmed, repeating the course of the previous warm air. Thus the atmosphere is a great agent in *tending* to equalise the mean temperatures of climates in various latitudes. Besides, the aërial currents are vehicles for the transfer of clouds, for producing electrical discharges, for clearing away malaria, and are turned by the ingenuity of man to promote his industry and extend his knowledge of the globe which he inhabits.

The atmosphere, considered as a transparent medium, has also great effects on light by its refractive power, and the reflection of the aqueous masses it contains. Hence arises twilight, which mitigates the transition of day to night, and from the duration of which it is easy for the astronomer to compute that altitude of the atmosphere at which it ceases to act sensibly on light, either from its total absence or extreme tenuity. This altitude is from forty to fifty miles above the level of the sea. Again, by the refractive power of the atmosphere distant terrestrial objects are elevated to the view when the spherical curvature of the earth would otherwise have caused their concealment; various optical illusions, as the mirage, fata morgana, &c., are all easily explained from the same refractive power under peculiar circumstances of temperature. By this medium sound is conveyed and odours are, at least in part, disseminated; the clouds which float in it soften the direct glare of the solar beams, and its aqueous particles, fluid or frozen, produce the beautiful phenomena of haloes, rainbows, false suns, &c. Its greater specific gravity elevates the balloon, by means of which the nature of the upper strata of the air below the altitude of between four and five miles, may be ascertained, and the barometric elevation and temperature observed, which furnish data for calculating the physical limits of the atmosphere.

With regard to the extent of the atmosphere, we may consider it under two points of view: first, the extreme limits to which it is possible for it to extend, considered mathematically as a mass rotating round the terrestrial axis in the same time; secondly, the much narrower physical limits founded on its nature as an elastic fluid, and having regard to the great diminution of temperature at high altitudes.

Any particle of the revolving atmosphere is acted on by two forces, namely, gravity, which is directed nearly to the centre of the earth, and the centrifugal force produced by rotation, which is directed according to the line by which that point is orthographically projected on the earth's axis, and tends directly from that axis. The former force varies inversely as the square of the distance from the earth's centre; the latter, directly as its perpendicular distance from the earth's axis. At any point taken in the external surface of the atmosphere, the resultant arising from both forces must be normal to that surface, in order that its form may be permanent. At the terrestrial equator the ratio of these two forces is known; as we ascend in the atmosphere along an equatorial radius produced, gravity diminishes and centrifugal force increases, both in this instance being directly opposite: hence it is easy to calculate the distance of a point in that radius where the two forces are exactly equal. Beyond that point the centrifugal force predominates, and no particle there situated could remain attached to our atmosphere, revolving with the earth both in its diurnal and orbital motions.

The above point therefore defines the extreme limit to which it is *possible* for our atmosphere to extend, and which is at a distance of about 30,000 miles from the centre, or 26,000 from the earth's equatorial surface, though it by no means follows that it must extend so far. Other data would be necessary to give the actual extent; for instance, the height of the barometer at the surface of the sea, and the law of the diminution of temperature in the upper strata of the air. The figure of the extreme surface can however be determined from these considerations, which is that of an oblate spheroid flattened at the poles, and in which the polar axis is to the equatorial in the ratio of 2 to 3.

As the phenomenon of twilight indicates an extreme degree of rarefaction in the atmosphere at an inconsiderable altitude above the earth's surface, we shall now consider some of the physical causes which demonstrate that the actual limits of that fluid are much more contracted than the extreme possible limits given above.

Representing by p, δ, and t respectively, the pressure, density, and temperature of the air at the surface of the earth, and by p', δ', and t', like quantities for a portion of air at a certain elevation, it follows from the general laws of gaseous bodies that $\frac{p'}{p}=\frac{(1+\beta t')\delta'}{(1+\beta t)\delta}$, where β represents the fraction $\frac{3}{800}$. Now the pressure measures the elastic force of the aërial particles: this elasticity cannot become negative, and ceases to exist when $p'=0$, which may happen either because $(1+\beta t')=0$, or $\delta'=0$. This last supposition would bring us to the consideration of the mathematical limits above treated on; the former, to the physical limits depending on the decrease of temperature at high altitudes, hence the air ceases to be an elastic fluid, according to this reasoning, when $t'=-\frac{1}{\beta}=-\frac{800}{3}=-266\frac{2}{3}^\circ$ centigrade. Now the law of the decrement of heat in the atmosphere proceeds in a progression quicker than an arithmetical, and as the plane of perpetual snow is at a comparatively small altitude in climates of mean temperature, it is easy to see that from 100 to 200 miles altitude would be sufficient to diminish the temperature to the above number of 266° below zero. Even if the simple law $p=(1+\beta t)\delta$ was not strictly rigorous at such low temperatures as −266° centigrade, still a diminution of temperature for a given density would produce a diminution of elasticity, and scarcely interfere with the general conclusion arrived at from that law.

But even limits thus obtained would, in all probability, be still too extensive, for it is not necessary that the elasticity should be totally destroyed: it is sufficient that the repulsive power of two contiguous particles of air at that altitude shall be less than the force of gravity, and if these two forces are equal, it will be the extreme extent at which the air can remain attached to the globe, leaving out of consideration the centrifugal force, which at that altitude is inconsiderable, and which would itself tend to remove those particles. Hence the limits become still more contracted by this consideration, and it will not be necessary that the temperature should be as low as −266°.

Some have imagined that planetary atmospheres are due to the attraction of the masses of the planets on a rare elastic fluid disseminated through space, but this supposition will not bear investigation; for putting aside the consideration of the extreme cold of the planetary spaces, this hypothesis is not corroborated by the dimensions of the atmospheres of the sun and planets, which would then depend on their masses, and the present total disappearance of the satellites of Jupiter behind their primary would be converted into an annular appearance round his body at the time of the eclipse of a satellite.

We have seen that the unequal distribution of heat in the atmosphere is a main source of the velocities and directions of winds, and consequently of the distribution of climate; but on the other hand, the earth itself, having its own distribution and radiation of heat, reacts on the atmosphere and produces dew, hoar-frost, &c. In like manner the sea and the Polar fields of ice materially affect the general distribution of heat.

The general causes of the temperature of the globe are the radiation of the sun, and the proper heat of the earth and its radiation; their effects however are greatly modified by various local circumstances, such as the vicinity of seas or mountains, and the difference in radiating power of the soil, together with the conducting powers of the strata subjacent to the particular places, with other causes less permanent.

With respect to the proper heat of the earth, we observe in any latitude that at a depth which is very small compared with the radius of the globe, the temperature is permanent throughout the year, the effects of solar radiation being confined to a superficial stratum of inconsiderable thickness. This fact has been fully established by long continued observations in the cellars of the Observatory at Paris, and by observations in the mines of Cornwall, in Scotland, and in other countries. If this stratum be supposed to be stripped off, the internal nucleus may be considered as nearly a spherical mass, arrived at a permanent state of temperature in each part, and subject at its external surface to a given distribution of heat, or to a given power of exterior conductibility. The depth at which this permanence of temperature occurs is different in different latitudes, inasmuch as the solar action on the superior stratum is also different on account of the greater or less obliquity of its rays, and likewise on account of the earth's elliptic annual motion. Thus we have the following observed relations between the permanent temperatures and the corresponding latitudes :—

	Lat.	Permanent temperatures.
Equator	0°	78°
Cairo	30°·2	72°·50
Paris	48°·50	53°·60
Berlin	52°·40	49°·28
Vadso	70°	36°·

The analytical equation for the propagation of heat in solids of any form, is—

$$\frac{dv}{dt} = \text{K}\left\{\frac{d^2v}{dx^2} + \frac{d^2v}{dy^2} + \frac{d^2v}{dz^2}\right\},$$

where v represents the temperature at a point of which the rectangular co-ordinates are x, y, z, and the constant K depends on the interior conducting power, and t is the time. In the case of a sphere with a radius R, we may place the origin of co-ordinates at the centre, and transforming the above from rectangular to polar co-ordinates (namely, r, the distance from the centre, θ the angle formed by the radius vector with an axis, and ϕ the inclination of the plane of θ to one of the co-ordinate planes, the angles necessarily disappear from the transformed equation, and) it becomes

$$\frac{dv}{dt} = \text{K}\left\{\frac{d^2v}{dr^2} + \frac{2}{r} \cdot \frac{dv}{dr}\right\},$$

on the supposition that the exterior permanent temperatures were uniform; to which we must annex the following equation for the surface, $\frac{dv}{dr} + h\,(v - a) = 0$, where a represents the temperature of the medium in contact with the globe, and h the index of exterior conductibility of the globe. But in the case of the earth both K and h are variable, and the former must then be brought under the sign of differentiation. After there shall have been a greater number of observations on the permanent interior temperatures of the earth, the above equations will be very useful in enabling us to calculate the temperatures at depths under the surface greater than it is probable man can ever penetrate, and they will assist in the explanation of the numerous phenomena which depend on the internal heat of various parts of the globe, as volcanoes, thermal springs, &c. Regarding the interior parts which are sufficiently remote from the surface as in a state of permanent temperature, we should have $\frac{dv}{dt} = 0$; when the preceding equations admit of easy integration on the supposition that K is constant, and of approximate solutions on a probable form of the function K when variable. [REFRIGERATION OF THE GLOBE, and TEMPERATURE, TERRESTRIAL, DISTRIBUTION OF.]

With respect to the heat of the external stratum, it is principally dependent on the radiation of the sun, the effect of which depends on the duration and the obliquity of the solar rays, both of which are dependent on the declination of the sun and the latitude of the place. The integral taken throughout the year depends therefore solely on the latitude: from this integral the calculated mean temperature is derived, but differs in most cases from the observed inasmuch as the propagation of heat in the sea and in the air affects unequally those places in the same parallel which are near to or distant from the coasts, and the unequal quantity of continent in the northern and southern hemispheres produces a similar result with respect to them.

The direct heat of the sun being unequally distributed over different parts of the globe is the primary cause of the variation of climate; its diurnal action on land is sensible only for a few inches in depth; the annual action however extends throughout the superior stratum of variable temperature above mentioned. The mean temperature of a place is generally estimated by taking the average of the diurnal temperatures during the four seasons of the year, and again taking the average of these four averages.

As there is a great variety of temperature in the same parallel of latitude, we cannot have a formula dependent only on this element to express the heat of places on continents. The first approximate formula to that effect which deserves the name, is that given by Mayer, the celebrated astronomer; though empirical, it is found to possess considerable exactness. If t be the mean temperature in degrees of Fahrenheit's thermometer, he makes $t = 84 - 52 \sin^2 \text{L}$, where L is the latitude of the place. The supposed facts which evidently suggested this formula were the equatorial mean temperature of 84°, which is now generally supposed to be too high; the Polar mean temperature of 32°, or the freezing point, which, from the recent observations of Parry, Scoresby, &c., is now known to be far too great; and thirdly, that the diminution of heat from the equator to the poles must proceed according to some even power of the latitude in order to amount to the same quantity in equal latitudes north and south, for which reason he chose the least even positive power of the sine. However, since the quantity of land in the northern hemisphere is about three times as great as in the southern, the solar heat accumulates more in the former, and in the latter is more equable between winter and summer. Sir D. Brewster has substituted for Mayer's the formula $t = 81°{\cdot}50 \cos \text{L}$, which bears an exceedingly good comparison with observations, but for the reasons above given he has found it necessary to modify it for the New World. Mr. Atkinson has shown that the mean of the errors of Mayer's and Brewster's formulæ for ten places nearly on the level of the sea are respectively + 1°·72 and − ·12. The temperatures of April and October are generally nearly the mean of the year, which also is found to vary but little in a considerable succession of years. If T be the mean temperature at an altitude h in feet, in a given place where t is the temperature of the surface, to express T, Mr. Atkinson has proposed the formula $\text{T} = t - \dfrac{h}{251 + \dfrac{h}{200}}$, giving for the extreme atmospheric cold the temperature − 200°, which is probably near the truth.

The names of Isotheral, Isocheimal, and Isothermal lines have been given to lines passing through places which have equal mean summer, winter, or annual temperatures, the two former having contrary courses, and the third intermediate. The difference of latitude between places in the New and Old Worlds, on the same isothermal line, is considerable, as appears from the following table :—

Isothermal line of Temperature.	Places.	Latitude.	Longitude.
32°	Near Uleo, Lapland, . .	67°	20° E.
	and		
	Table Bay, Labrador . . .	54°	58° W.
41°	Stockholm	60°	18° E.
	and		
	St. George's Bay, Newfoundland	48°	59° W.
50°	Belgium	51°	2° E.
	and		
	Boston, U. S.	42½°	71° W.
59°	Near Rome	43°	11⅔° E.
	and		
	Raleigh, N. Carolina . .	36°	76½° W.

or we may average according to latitude thus :—

Latitude.	Mean Temperature of West of Old World.	Mean Temperature of East of New World.
30°	70·52	66·92
40°	63·14	54·50
50°	50·90	37·94
60°	40·64	23·72

The mean temperature in the latitude of 34° in different continents, and at places near the sea, is found to vary but little, thus :—

Places.	Continents.	Latitudes.	Temperature.
Cape of Good Hope . .	Africa	33° 51′	66°·7
Port Jackson, N. Holland .	Australia	33° 53′	66°·9
City of Buenos Ayres . .	America	34° 36′	67°·5

The sea varies in temperature much less than the air; the region of warmest water extends about 5½° on each side of the equator, but rather farther to the south than to the north. There are two points of maximum cold near the North Pole; one of 3½° Fahr. in the neighbourhood of Melville Island, and another of 2° Fahr. somewhere about the 79th degree of north lat., long. 120° east. The isothermal curves, "accordingly, about the North Pole bear no inapt resemblance," as remarked by Sir David Brewster, "to the isochromatic lines, or coloured sphæro-lemniscates exhibited by polarised light in a biaxal crystal, whose optic axes are inclined to each other about 30°, having the pole itself almost centrally situated between them, and their line of junction nearly coincident with that diameter of the polar basin which intersects it, and passes through its two great outlets into the Pacific and Atlantic oceans—a most remarkable feature, strongly indicative of the absence of land, and of the prevalence of a materially milder temperature (possibly not averaging below 15° Fahr.) at the actual pole. Of the point or points of maximum cold in the southern hemisphere we know nothing." An unexpected and most interesting consequence has followed from Sir D. Brewster's recognition of the resemblance of the north polar isothermal curves to the isochromatic lines of polarised light in the case described. Sir John F. W. Herschel has found that there is a coincidence between the two sets of curves, "in respect of the arithmetical progression of temperature in the one series corresponding to that of chromatic sequence in the other," which he points out "as something different from and additional to a mere general resemblance of form;" though "it will of course be understood," as he observes, "that we have not the slightest intention of tracing any *physical analogy*" between them. What the relation can be, of which this coincidence is a result, it is impossible to say; but it is important in this place to indicate the bearing of the coincidence upon Mayer's formula, expressing the diminution of heat from the equator to the pole. Sir J. Herschel shows that if a series of curves be traced by calculation from an equation derived from and equivalent to the general equation of the optical curves in question, for temperatures varying from a certain mean temperature thermometrically indicated, and from each other, by equal thermometric intervals, these curves, "in respect of their magnitudes, distances from their foci and the pole, as well as in their general gradations of flexure, will coincide, or nearly so, with a series of isochromatic curves *equidistant in their orders of tint.*" This latter series, if laid down on a map, will divide the meridians in the polar regions in a succession of points distributed over them according to a certain law of progression. By calculation from these data, he obtains equations, of which he says: "Now it is remarkable that this is precisely the form in which Mayer endeavoured to express empirically the decrement of temperature in proceeding from the equator towards the pole, from such observations as could be obtained about the middle of the last century." The details of this curious subject are given by Sir J. Herschel in his article Meteorology, 'Encyc. Brit.' pars. 192 to 194.

The production of winds, we have already stated, is mainly attributable to the unequal distribution of heat in the atmosphere. The attractive action of the sun and moon on that fluid, though producing atmospheric tides, which are believed to have been recognised by barometrical observations, could only produce a tropical wind with a velocity of 4 miles per day, which would be evidently inappreciable amongst the numerous disturbances arising from temperature; but the heating action of the sun in tropical climates produces some well-known winds in the following manner.

On account of the annual accumulation of heat from the solar rays between the tropics, two currents of air from the north and south rush forward to occupy the place of the rarified air of this region. Now since the earth in its diurnal rotation moves from west to east, these currents appear to deflect to the west on account of the increased velocity of the parallels of latitude near the equator, which have greater radii than the arctic parallels, the apparent excess of motion towards the west being the excess of the space described in rotation by the equinoctial above that described by the tropical and even polar circles; the velocities perpendicular to the equator, being nearly equal and contrary, produce no sensible wind, but those parallel to it produce a wind directly west and enduring, called the "trade-wind," with this exception, that the northern hemisphere being the warmer, the resultant is a few degrees north of the equator, crossing the Atlantic from Africa to Brazil, and the Pacific from Panama to the Philippine Isles, and the Indian seas from Sumatra to Zanguebar. But when the continents stretch into the torrid zone, the local accumulation of heat being great, two opposite periodical winds, known by the name of *monsoons*, are produced, approaching the north tropic in summer, and the south in winter, and blowing in the Arabian and Indian seas north-west from April to October, and in the contrary direction during the rest of the year: the reverse occurs south of the equator.

Now as the cold air rushes into the tropical regions, expelling the warm air of that locality between 28° on each side, the warm air forms a counter-current, still possessing equatorial velocity, and produces in both hemispheres exceeding the above latitude a westerly and genial breeze, which is felt during three-quarters of the year from Newfoundland to the west of England, and from South America to the Cape of Good Hope. On the same principle the easterly, or rather north-easterly winds originate in the polar currents, and are piercingly cold in general. The great radiation of arid plains produces many local winds, such as the sirocco from Africa to Italy, and the destructive simoom of Arabia, &c., but they do not depend on general atmospheric causes.

The greater number of the several subjects the knowledge of which constitutes the science of Meteorology, will be found distributed throughout this division of the 'English Cyclopædia' in alphabetical order. But it may be useful to the reader and student to refer to the more important of them in this place, arranged under the heads of the principal branches of the science. That of the form, general nature, and extent of the gaseous envelope of the earth is treated of under **Atmosphere**, and partially returned to in the article **Comets**, *Physical Constitution of.* In the first-named article, and also under **Air**, its chemical nature and relations are described, and its agency in changing the condition of the bodies composing the earth's surface and employed in human constructions, under **Atmospheric Influence**. The articles **Actinometer**, **Temperature**, and **Thermometer**, belong, the first entirely, and the latter in part, to its relations to heat; while some consequences of its action on light are described in those of **Aërial Perspective**; **Reflection** and **Refraction, Atmospheric**; and **Twilight**. The subject of the pressure of the atmosphere and its variations, and their connection with the weather, are explained under **Barometer**; **Boiling of Liquids**; and **Manometer**. The consequences of the changes induced by variations of temperature in the aqueous constituent of the air, forming so important a branch of practical Meteorology, are described under the following heads: **Clouds**; **Dew**; **Dew-point**; **Evaporation**; **Hail**; **Hoar-frost**; **Hygrometer** and **Hygrometry**; **Mist**; **Rain**; **Rain-gauge**; **Snow**; **Thaw**. The phenomena dependent upon the mechanical affections of the air, and the philosophy of winds, storms, and cyclones, are treated of in the articles **Aëro-Dynamics**; **Air**; **Anemometer**; **Atmosphere**; **Calms**; **Fluids, Elastic**; **Monsoon**; **Samieli**; **Sirocco**; **Tornado**; **Typhoon**; **Whirlwind**; **Wind**. The electrical part of meteorology will be found under **Electrical Light**; **Electricity, Atmospheric**; and **Lightning**; a certain subject relating to this branch of the subject being also noticed under **Breath-figures**. **Climate** and **Weather**, and the special subjects of **Dust, Atmospheric**; **Ignis Fatuus**; **Meteors, Igneous** or **Luminous**; and **Polar Lights**, are discussed under those heads.

METEORS, IGNEOUS or LUMINOUS. The following is a condensed statement of the present condition of knowledge in the department of meteorology relating to these objects, which may now not improperly be termed meteoric astronomy, and which is connected in a remarkable manner with cosmical science, and also with almost every branch of physics and of the study of inorganic nature.

The spaces through which the bodies of the solar system and the comets revolve about the sun, appear also to be traversed by celestial bodies comparatively minute, but in number incalculable; which, in common with the smaller true planets of the system have received from certain astronomers and physicists the appellation of Asteroids, or star-like bodies—the word star being taken in its universal and ancient sense of any luminous object seen in the heavens. [**Asteroids.**] Zones of these bodies, consisting of countless myriads of them, we have much reason to infer, revolve about the sun in nearly their own planes, or in some plane which they include; and certain astronomers consider that some of them have been proved to be minute satellites of the earth, as was believed, indeed, early in the scientific history of this subject.

These smaller asteroids, when they approach within a certain comparatively small distance from the earth, are, or subsequently become, the objects termed shooting-stars, fire-balls, and igneous meteors; new series of phenomena being successively presented by them as they come nearer to the earth's surface, and especially in many instances, in consequence of their finally passing through a great extent of the atmosphere in an oblique direction, so as to experience the effects of its increasing density, both physical and chemical, throughout a trajectory of great length. But in this general statement it is not pretended to deny that objects and phenomena very different in their origin and nature, as well from each other as from those now under review, may probably be included also under the popular or only half-scientific designations of meteors and shooting-stars.

The appearance of these meteors is in many cases attended or succeeded by the fall of solid bodies, either stones or metallic iron, or in some cases both mingled together in the same block, forming a series of bodies collectively termed Meteorites (or **Aerolites**, in **Nat. Hist. Div.**), consisting, mineralogically, of two principal groups, graduating into each other, namely, meteoric stones, and meteoric iron; and which have also received the appellation of *Meteoric Rocks* in the classification of the mineral aggregates to which the term *rock* has in modern science been extended.

The visible meteor, when observed at those distances which must be within the atmosphere, must consist of flame or gaseous matter in an ignited or incandescent state, and undergoing combustion; but arising, as may be inferred from Sir H. Davy's researches on flame, not from the combustion of matter which under ordinary circumstances can exist in a gaseous state at the surface of the earth; but from that of matter which is there solid, consisting, doubtless, of the metallic or other combustible bases which meteorites are found to contain. Among these, it may be remarked, are sulphur and phosphorus, both which Davy particularised as capable of combustion in air rarefied to a degree equal to that of the regions of the atmosphere in which meteors had been observed to display their phenomena. No particular stress, however, can be laid upon this circumstance, as meteorites contain other combustible bases which very probably have the same property, including the metal magnesium, an element of almost every meteoric stone, in considerable proportions. The extraordinary intensity of light also which attends the combustion of magnesium in oxygen, may be connected with the brilliant phenomena of the meteors.

The luminous extensions in the directions opposite to that of the meteor's motions, ordinarily called tails, as observed in many, if not in all igneous meteors, are manifestly referable to the elongation of the mass of flame constituting the visible meteor, by the resistance of the atmosphere to their progress through it with planetary velocity, as well as in some degree by the adhesion of the air to it; the passage from the intense white light of the head or body and proximate portions of the tail, to the red light of the distant and extreme portions of the latter, being attributable to the cooling down of the flame during its course, and in proportion to its distance from the most intensely heated part of the meteor.

It would appear, both from theory and observation, that the figure of the meteors must approach in their course more or less closely to that of the solid of least resistance. The meteorites which fall, or are cast down from them, when unbroken, especially those consisting of metallic iron, retain approximately the form which had thus been imparted to the meteors of which they were the nuclei, by the resistance of the air,—a form resembling that of the more perfect volcanic bombs, and which they have received from the same cause. These effects of the resistance of the atmosphere to the meteor's motion were first pointed out by Mr. Brayley.

The persistent track or trail of less vivid light often continuing to be seen for several minutes, or for a considerable fraction of an hour, or even for more than an hour, after the disappearance of the meteor itself, must be attributed to the deposition in the atmosphere, in the meteor's path, of a kind of beam of finely-divided solid matter, mingled probably with vapour, and no doubt in part produced by the condensation of vapour resulting from the combustion proceeding in the meteor, and the particles of which, being originally deposited at insensible distances from each other, continue to preserve, during their slow and uniform descent in the tranquil regions of the air where they originate, the aggregate form in which they were deposited; while the low conducting power for heat of the rare atmosphere permits them to retain their high temperature and consequent luminosity for a comparatively long period of time. The continued action of gravity, and the disturbing agency of currents in the lower regions of the atmosphere will, however, eventually convert the at first rectilinear beam into a more or less curved and waved figure, and at length produce the serpent of fire of the superstitious ages, accurately reproduced in the case of the meteor of the 7th January, 1856, as witnessed at Tunbridge Wells, and represented by a correspondent of the 'Illustrated London News,' of the 12th. These views are supported by reference to telescopic observations of the trails, particularly by those of the late Professor Pictet, of that left visible for seven or eight minutes by the meteor seen in France and Switzerland on the 15th of May, 1811, the most luminous part of which "did not appear to be continuous, but composed of distinct and separate particles."

The production, continuance, gradual change of form and descent, and final dissolution of these trails, may be familiarly, but correctly, illustrated by comparison with the similar succession of phenomena characterising the trail of smoke and soot issuing from the funnel of a steam ship during its progress on its course, in which also a rectilinear beam of finely divided solid matter separated from flame and smoke, and often several miles in length, becomes a persistent trail, and gradually changes into a waved or serpentine form. In many cases the trail of a meteor must have been originally a cylindrical beam, constituted as now explained, having a diameter of many hundred yards (equal to or greater than that of the meteor itself), and a length of many miles, deposited in an inclined direction, at heights of some miles above the earth's surface.[*]

An objection founded on the assumed solidity of the particles, and the considerable specific gravity which must be attributed to them as results of the combustion going on within the meteors, which, it might be inferred are inconsistent with their long suspension in the manner supposed, is at once obviated by applying to the subject the results of Professor Stokes's researches on the effects of the internal friction of fluids as applied by himself to the suspension of fine powders in a fluid of widely different specific gravity, and to that of the suspension in the air of the minute globules of water constituting the clouds. [CLOUDS.] The trails of meteors are suspended like the clouds, though, at first, probably, in higher regions of the atmosphere, and like them they consist of excessively minute particles, which, as in all probability their dimensions will be very nearly the same in all directions, may be regarded as spherules also, and will consequently be suspended temporarily, like the globules of the clouds, by the resistance to their downward motion arising from the internal friction of the air. The degree in which they partake of the projectile motion of the meteor itself, will also tend to their longer suspension, by converting the perpendicular fall which the mere action of gravity would cause into an oblique curvilinear descent.

The two great causes of all the phenomena now described, are evidently the motion and the heat of the meteors. The origin of the former is doubtless involved in that of the portions of matter constituting the nuclei of the meteors themselves, a subject noticed below. Dr. Chladni, the earliest philosophical investigator of the subject of meteors and meteorites (as a whole), and in later times Sir H. Davy, and Sir John F. W. Herschel, have ascribed the heat to the compression and friction of the air, resulting from the enormous velocity, of from six to thirty miles in a second, or more, of the meteors, supposed to be solid when they enter the atmosphere. Still more recently, in a paper read before the Royal Society on the 19th of June, 1856, Dr. Joule and Professor William Thomson have inferred from their own experiments on the thermal effects of fluids in motion, to which those of solids carried through fluids must be equivalent, the great probability that meteors really acquire all the heat they manifest from the friction of the air. In a communication made by Dr. Joule to the Section of Mathematics and Physics of the British Association, in 1859, he affirms, reasoning from the concluding series of experiments on the heat developed by friction in air, made by him and Professor Thomson, that "there remains no doubt whatever as to the real nature of 'shooting stars.' These," he says, "are small bodies which come into the earth's atmosphere at velocities of perhaps twenty miles per second. The instant they touch the atmosphere their surfaces are immediately heated far beyond the point of fusion, or even of volatilisation, and the consequence is, that they are speedily and completely burnt down and reduced to impalpable oxides." If this be true, the persistent trails of igneous meteors, which are left in the sky equally by the smaller as by the larger, (though continuing, with the former, for a much shorter space of time,) will consist of the particles of these oxides, or perhaps of particles condensed from the vapour into which the oxides are first converted; agreeably to the explanation of their nature already given in this article, as derived long ago from applying the facts made known by Davy, relative to combustion in rarefied air, to the observed phenomena of meteors.

In the present state of cosmical and meteorological science, it is unnecessary to enter upon the question of the origin of meteors and meteorites further than to urge, that, the computed enormous magnitude of the former,—the actual diameter of the visible meteor, however constituted, being often many hundred yards, while in some instances its dimensions must probably be expressed in miles,—their planetary velocity and the pregnant fact that they give out a more intense light than any objects in nature except the sun, (an assemblage of characters explicitly claimed by the writer of this article for the particular meteors from which meteorites have been observed to descend, as well as for many, if not all of those from which their fall is not known), must at once disprove nearly all the hypotheses which have been framed specifically to explain the origin of meteorites; and especially, among others, that of their projection from lunar volcanoes. The cogency of this argument will remain essentially unimpaired if it shall be found, according to recent suggestions, that the actual magnitude of many of the meteors is considerably less than that hitherto ascribed to them. The problem of their origin must in fact, be regarded as the same with that of the origin of the greater asteroids and planets themselves.

It is right to state that Mr. R. P. Greg, F.G.S., who has given much attention to the subject, is of opinion that there is a distinction between luminous meteors and those from which meteorites have fallen; an opinion which, so far as the (apparently) smaller meteors called shooting stars are concerned, he shares with the American Professor Olmsted and others. Mr. Greg is the author of a valuable essay on meteorites, entitled 'Observations on Meteorolites or Aërolites, considered Geographically, Statistically, and Cosmically; accompanied by a complete Catalogue of Meteoric Falls.' It was first published in the 'Philosophical Magazine' for November and December, 1854, and in a separate form in November of the following year.

The views of the entire subject which have been enunciated in this article, have resulted from long attention to it by the writer. Others will be found, together with an invaluable assemblage of facts, in Arago's 'Astronomie Populaire,' liv. xxvi.; 'Météores Cosmiques,' tome iv., p. 181–322; and also in the reports on meteors annually communicated for some years past to the reports of the British Association by the late Professor the Rev. Baden Powell.

The purely physical history of the subject having now been generally considered, we may proceed to notice the manner in which the extraordinary relations produced in former times, of the appearance in the sky of blazing torches, sceptres, bundles of rods, fiery swords, trumpets, and other objects, may be rationally interpreted, agreeably to our present knowledge of meteoric phenomena. This subject belongs to a field in the history of science and literature hitherto but little cultivated. It may be elucidated by examining the figures and accounts of such appearances which are given in the works of old writers, especially in those of Zahn, Conrad Wolfhart, and their contemporaries, and also by Ambrose Parey, and comparing them with similar phenomena as witnessed in more modern times, and depicted by observers whose only object was to represent the actual configuration of the luminous appearances.

The circumstance that from the enormous rapidity of the meteors all the visible phenomena (except the persistent trail) would have been seen and have ceased to appear within the limits of a few seconds of time (so that in all cases the figures must have been produced from memory alone), which must have led to the representation of many appearances as simultaneous that in reality occurred in succession, and the manner in which, during the transit of the meteor, impressions on the retina of past phenomena must have been mingled with those actually present, have led to the production of many of the singular representations that are extant. It would not be difficult to trace the mental process by which natural objects, thus witnessed for a few seconds only, would by uninformed observers, prepared to regard them with superstition, be supposed to be really preternatural types of the familiar objects to which the outlines of their forms were comparable; the meteors, thus supposed to be torches, swords, and the like, would naturally be described and depicted with all the appendages and accompaniments of those objects. These accompaniments, however, were not in all cases merely suppositions, as may be evinced by reference to the great meteor of 1758, which exemplified the ringed sceptre of the mediæval figures, the rings on the shaft being manifestly the smaller meteors, the production of which is the first visible result of the explosion, seen as projected upon the tail of the parent meteor; either because, as is evidently the fact in many instances, they were really enveloped in the flames composing it, or on account of the blending upon the retina of the observer of past and actual appearances. The fiery sword dipped in blood is the meteor in its normal form, at the middle of its visible course, the distant part of the tail shining with red light, being cooled down to the temperature of simple ignition, as already indicated. In a similar manner, the bull's heads, flying eagles, and other monstrous appearances, may be consistently explained, care being taken, when the authorities permit, to identify them with the actual meteor otherwise recorded. The blazing and interlaced serpents moving in the air may be explained by reference to the actual phenomena of the persistent tracks or trails already described, as witnessed in various cases by Pictet and others, as well as by the published representations of the meteor of January 7th, 1856. One instance may be cited, in which a large and beautiful luminous serpentine train continued for some minutes after the disappearance of a meteor which threw down a stone at Angers, in 1822. The ensanguined tresses attached to blazing stars are evidently the trails under another phase, and in their later condition, emitting red light only, but retaining their linear or band-like form. The *Lampades volantes* and *Dracones volantes* of former ages may be similarly understood, by reference to other characters and phenomena of meteors; one of the contemporary figures of the fire-ball seen in London on November 13th, 1803 (described under other phases by Dr. Firminger, in the 'Philosophical Magazine' for the following year), exemplifies the particular configuration of the meteors to which the latter appellation was given: it is contained in Nicholson's 'Philosophical Journal' for 1804.

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[*] These views of the physical constitution of meteors and their trails were in substance originally stated by Mr. Brayley, in a paper read in 1824 before the Meteorological Society then recently formed, and published in the 'Philosophical Magazine,' 1st series, vol. lxiv., p. 288, &c. With additions and modifications required by the progress of science, they have been subsequently often repeated by him, in lectures delivered at the Royal Institution, and in several courses at the London Institution.

METHIONIC ACID ($C_2H_2S_4O_{10}, 2HO$), *Disulphometholic Acid.* This acid is obtained by heating cyanide of methyl with concentrated sulphuric acid:

$$\underbrace{C_2H_3Cy}_{\text{Cyanide of methyl.}} + 5(SO_3\,HO) = \underbrace{C_2H_2S_4O_{10},\,2HO}_{\text{Methionic acid.}} + 2CO_2 + \underbrace{NH_4O\,SO_3}_{\text{Sulphate of ammonia.}}$$

It is only of theoretical importance.

METHODISM, a very memorable word in the English vocabulary, as the thing signified is also very memorable in the history of the Christian church, and especially of that part of it which consists of inhabitants of the British Isles.

The people of England have been described by foreign writers as being beyond all other nations *religiosissimi*, or very strongly devoted to religious thoughts and exercises. The success of Christianity on its introduction into this island is one proof of it; but still more is the great encouragement given to the religious orders, and the multitude of churches which were erected in the very earliest periods. A few centuries later, we have the proof which is afforded by the great encouragement which the different orders of friars received, who were a species of Methodist preachers of the middle ages.

Each century seems to have had its schism arising in this national characteristic. In the 15th there were the *Lollards*, who were easily put down by the Church; in the 16th, the *Gospellers*, who, having the court with them, brought about the Reformation; in the 17th, the *Puritans*, who were for a short time triumphant, but who were finally reduced to the several denominations of dissenters still existing, the *Presbyterian*, the *Independent*, the *Baptist*, and the *Quakers*. In the 18th century, when not only the Church but the several dissenting bodies were thought by many to have lost much of the spirit and fervour of religion, there arose the *Methodists*, who, being allowed to proceed unmolested, have produced, without having attempted to overturn the Church, no small change in it, in modifying its ministrations, in calling back attention to the supposed doctrines of its founders, and in rousing its ministers to more strenuous exertions.

It is interesting to observe the various forms in which Methodism is presented, and we see it more strikingly in the various sects which are called the Methodist sects, and which are in fact so many different classes of persons who collectively are called Methodists. There are:—1, the Wesleyan Methodists; 2, the Methodists of Lady Huntingdon's Connexion; 3, the Methodists of the New Connexion; 4, the Primitive Methodists; 5, the Bible Christians; 6, Protestant Methodists; 7, Association Methodists, now united with a portion of the Wesleyan Reformers, under the designation of the "United Methodist Free Church;" 8, the Inghamites; 9, the Wesleyan Reform Union, comprising those Reformers who declined to form part of the United Methodist Free Church. There is also a large body of persons, chiefly in Wales, calling themselves Calvinistic Methodists, who are not included in what is called Lady Huntingdon's Connexion.

The year 1729 is considered as the time at which Methodism began. It is not intended in this article to give a biographical notice of the founder of Methodism. This will be found in its more appropriate place. [Wesley, in Biog. Div.] Under the word Whitefield, in Biog. Div., will also be found a notice of George Whitefield, another student at Oxford, who joined the Wesleys in 1732, and who had a large share with them in laying the foundation of Methodism. It may suffice for the present to say that the Wesleys and Whitefield, instead of following the usual course of clergymen, in settling down on livings, after studying in the university, undertook the wider duty of rousing their countrymen generally to a higher tone of devotional feeling, and to a regard to the doctrines of the Church, to which there was then, owing in a great measure to the writings of the Latitudinarian divines, and other writers, a growing indifference. Many were of opinion that the all-in-all in Christianity was the doing justly, loving mercy, and walking humbly, looking for that blessed hope and glorious appearing of our Lord and Saviour Jesus Christ, when every man should receive according to his works. Wesley went forth proclaiming that he came to call men back *to old Church of England principles.* This was his favourite phrase, as appears by many passages in his journals, and this object (at first, at least) was what he himself considered the chief purpose of his mission. What he meant was original sin, regeneration, the atonement by the blood of Christ, the influence of the Spirit, justification by faith, freedom of the will, accountability, and eternal reward or suffering; Whitefield added to these the eternal decrees, the extreme doctrines of Calvinism.

The object of neither of them was to be founders of sects out of the Church, but to produce a change within the Church. It was soon however manifest that their end could not be attained by remaining, even outwardly, conformable to the rules of the Church in regard to its ministers. The doors of the parish churches were soon closed against them, and the meeting-houses of the dissenters were closed likewise. They then preached wherever a congregation could be gathered together, in rooms or in the open air, and preaching with the zeal and energy of the Apostles, it was in vain, with a population like the English, to attempt to prevent them from making a deep impression. Such energy of preaching had not been witnessed since the time of the old Puritans. The effect indeed may be described as marvellous. The cry, "What shall I do to be saved?" was heard from many voices wherever they had an audience; sometimes this cry was accompanied by dreadful shriekings and faintings. The accounts given by friends and enemies are in respect of this the same. Many well-meaning persons regarded it only as a mischievous enthusiasm. By the profane the preachers were not unfrequently assaulted, and their lives placed in jeopardy. But many were soon found ready to assist them in their work, either by forming into societies persons convinced by them, and erecting chapels for their assembling together, or by taking upon themselves the office of teacher, and following in the track which their masters had trod. There were at the same time a few persons who were ministers in the Church, and who did not leave the parishes in which they were settled, who seconded the labours of these men. Such were Fletcher, Sellon, Perronett, Dickinson, Venn, Grimshaw, and others.

Whitefield died early, worn out by his extraordinary exertion. He was the founder of the Calvinistic section of Methodists. Of this sect of Methodists the original chapels have become, not adopting any connexional bond, Independents; but from it arose two separate sects, the Countess of Huntingdon's connexion, and the Welsh Calvinistic Methodists. The first has an endowed college at Cheshunt for the education of its ministers, with 109 chapels (accommodating 38,727 persons, at the census of 1851), in many of which the ritual of the church of England is used in a modified form. On Sunday, March 31, 1851, the attendance was, in the morning 21,103; afternoon, 4380; and in the evening 19,159. The Welsh Calvinists at the same dates had 828 chapels, with accommodation for 211,951 persons; and the attendance was, morning, 79,728; afternoon, 59,140; evening, 125,244. In 1853 they had 207 ministers, 284 lay preachers, and 58,577 communicants.

The life of Wesley was prolonged to his eighty-seventh year; and when he died, which was in March, 1791, he had been sixty-five years in the ministry, and fifty-two years an itinerant preacher; he lived also to see in Great Britain and Ireland about three hundred itinerant preachers and a thousand of what are called local preachers "raised up from the midst of his own people," and eighty thousand persons in the societies under his care. Such was the state of this one principal branch of Methodism at the time of Wesley's decease. Some thought that as it had grown with him, it would die with him: but they were mistaken. He had provided (as far as human means go) for its perpetuity by binding up his members in a church, with a frame and constitution as strong as could be given to it by subordination, authority, rules, common interest, and the bond of common property. Thoroughly regardless of accumulating personal wealth, the contributions of the members of his societies, which had long far exceeded the expenses, enabled him to transfer to the body of preachers, in whom, as in an assembly of presbyters, he vested it, whatever interest he had in a multitude of chapels in every part of England, and a large surplus fund; and this property, it is understood, has gone on year by year constantly increasing, notwithstanding the vast exertions which have been made in the erection of chapels, schools, and other buildings, the support of an additional number of preachers, and in missionary exertions among the people not yet converted to Christianity. It was in 1738 that the first Methodist society was formed by Wesley himself on his return from Hernhut in Germany, and in 1739 there were several chapels in London, the principal one being in Fetter Lane. In 1740 Whitefield separated from them. In 1743 the rules, which still continue in force, were drawn up for the London and other societies, especially those of Bristol and Kingswood, the part of the kingdom in which, at the beginning of his ministry, Wesley had chiefly laboured. These rules set forth, that the Methodists are a people who, in addition to the form of Christianity, seek the power of godliness, and manifest it by good works: the societies are united, that by counsel, exhortation, and prayer, they may assist each other in the great work of religion.

We proceed to describe the constitution of these societies and of the general union of them, forming the highly important class of Christians called the Wesleyan Methodists.

These societies are divided into classes of twelve persons generally, but sometimes more, and he that is supposed the best qualified by mental and religious excellency, is appointed the leader. His duty is to see his members weekly, to receive the voluntary contributions of his class, and to take the amount to what is termed the "leaders' meeting;" that is, the stated meetings of all the leaders and the society-stewards in a certain locality, where the society of the place is represented, and its affairs transacted. The society-stewards take the moneys from the leaders, pay the ministers their weekly stipend, and take the surplus to the circuit-stewards at the quarterly meeting. In the leaders' meetings are stewards for the poor also, who at the direction of the meeting give to the leaders, for their poorer members, whatever funds may be furnished by any society and congregation for that purpose.

A number of these united societies lying around some central town or large chapel is known as a circuit. The villages or chapels in the vicinity of the centre are regularly visited by the ministers at stated times for the purpose of conducting worship, and the discharge of other pastoral duties. In the origin of Methodism these circuits included not merely one county, but sometimes parts of several; but now, owing to the spread of Methodism, the circuits are limited to a diameter of twenty, ten, and in some cases of fewer miles. The societies and congregations in these circuits are committed to the care of the ministers yearly appointed by the Conference; and more especially to one who is termed the superintendent: generally, when compared with his fellow-ministers in the same circuit, he is of the longest standing in the connection, but not always so, as the Conference claims the right of appointing to this office the person whom it judges the most proper. To the superintendent principally the direction of the other ministers is committed, as well as that of the local preachers also, who are men in business and only occasional preachers; and in addition to the above, the superintendent has the care of the leaders, stewards, and, in one sentence, the whole circuit: he is accountable to the Conference for the use of the power committed to him.

At the May district-meeting, when the circuit-stewards have taken their departure, one of its ministers is chosen by ballot, as its general representative at the coming Conference. Then the meeting determines how many additional ministers belonging to the district shall be allowed to proceed to the Conference. The Conference, strictly and truly, consists only of one hundred preachers, whose names are in the deed that gives it a legal existence, but all the preachers allowed to go from the respective districts are suffered to sit therein, and vote as integral parts thereof. At the assembling of the Conference, one of its first acts is the choosing by ballot the president and secretary, who must be of the hundred—the legal Conference. The business which follows comprises the supplying of the places of those who by death, &c., have been removed, by the hundred, partly by ballot and partly by nomination; the examination of the character of every minister as to his moral conduct, Methodistical orthodoxy, &c.; the examination of the minutes of the several districts; and the appointments of the ministers for the coming year. Further, they legislate for, and determine the multifarious concerns of the connexion.

In Methodism, the members are divided into two great classes—the ministers and the people; and each, if accused, is tried at its separate tribunal, and by its own peers. The members are tried by the leaders' meeting; and the ministers by the ministers only, at a district-meeting. If either the members or ministers are dissatisfied with the decision of their respective judicatories, they may appeal to the Conference, the highest court of Methodism.

Methodism furnishes its ministers from the members, who first are known as local preachers, and then nominated at the March quarterly meeting as persons proper to be recommended for examination at the coming May district-meeting by the ministers alone. If the churches in the circuit, by their representatives at the quarterly meeting, recommend the person nominated, he appears before the district-meeting and undergoes an examination as to his personal acquaintance with Christianity, his Methodistic orthodoxy, and attachment to its discipline. If approved and recommended by the district-meeting, his name is brought before the next Conference. If all inquiries here are satisfactorily met, he is either immediately employed as a probationer, in which state he must continue for four years, before he can be admitted into full connection—that is, be ordained and permitted to administer the sacraments—or he may be placed on the list of reserve, and if approved, when again examined by the preachers in the London district, he will be admitted to the Theological Institution, and by training for some two or three years, be prepared for his work.

The doctrinal test of the Methodists is found in certain volumes of Mr. Wesley's Sermons, and his notes on the New Testament. Among the most prominent of these doctrines, next to the being of God, his perfections and worship, are—original sin, moral impotency, the sufficiency of grace, the atonement, general redemption, justification by faith, the witness and work of the Spirit, entire regeneration, good works as the fruits thereof, eternal life, and everlasting punishment.

The disciplinary test is found in the minutes of Conferences, the statute-books of the Wesleyans. While the ministers appointed by the Conference keep within the above limits, they have a right to the pulpits, and are beyond control. But any departure from the above will give authority to the trustees of any chapel in which un-Methodistical doctrine is preached, to require the chairman of that district to summon the ministers of the district, and the trustees of the circuit in which the supposed transgressor is found, and if at the district meeting so constituted his delinquency be proved, he may be suspended until the next Conference, when the whole case will be reviewed, and finally adjudicated.

While the ministers are irreproachable, the Conference claims the right of appointing them to all the chapels in the connection settled on the Conference plan, and this right is beyond dispute or control; but over the property of the chapels, the Conference has no control, except it be the giving or withholding permission to the trustees to sell, when this is craved by them.

The labours of Wesley were not wholly confined to England. He had made little impression upon Scotland, where the number of members at the time of his decease scarcely exceeded a thousand. But in Ireland he had about fifteen thousand, and in the United States there were about thirty thousand. Since his decease, the prevalence of Wesleyan Methodism in North America has been very great.

By the census of 1851, there were 428 circuits in Great Britain, with 1024 ordained preachers, and between 13,000 and 14,000 lay-preachers, who receive no remuneration, and there were 6579 chapels in England and Wales, with accommodation for 1,447,580 persons. The number of communicants was 358,277. On Sunday, March 31, 1851, the attendance at these chapels (including an estimate for 133, from which no returns were made), was—morning, 429,714; afternoon, 383,694; evening, 667,850.

The number of Scotch chapels by the census return was 82, of which 65 were open in the morning, 31 only in the afternoon, and 64 in the evening; the attendance was 8937 in the morning, 2563 in the afternoon, and 9516 in the evening; but there is accommodation for 22,441. The separation of the Wesleyan reformers, however, in 1850 and 1851, reduced the number of communicants in England and Wales to 270,265. In 1860 the returns to Conference show the members in society in Great Britain to be 277,589, with 26,683 members on trial, and 121,760 scholars.

In 1793 great dissensions existed about the sacraments, whether they should or should not be administered by the ministers, in the chapels, to the members of the society who required them as a part of Christianity. This led to secessions at Bristol and elsewhere. In 1795 many influential societies chose delegates, and sent them to the Conference then held at Manchester, for the purpose of claiming some share in the government of Methodism. This led to concessions as they may be found in the Plan of Pacification,—the Bill of Rights of the Methodists.

With these concessions many were not satisfied, and, being led principally by the Rev. Alexander Kilham, they seceded in 1797, and formed the *New Connexion*, a truly respectable body, who, in 1853, had 301 chapels, 95 circuits, 814 local preachers, and 16,070 members. In the report of the Conference of 1860, the total number of chapels, including Ireland and Canada, is stated as 473, preachers, 189; local preachers, 1204; members, 29,331; on probation, 2562; there were also 60,753 scholars attending their schools. Mr. O'Bryan, of the North Cornwall district, was the founder of the *Bible Christian Methodists;* they are sometimes called Bryanites. They were not seceders from the Wesleyan stock, but an independent sect, that gradually adopted the Wesleyan tenets. In 1852 they had 403 chapels, 113 itinerant ministers, 1059 local preachers, and 13,862 members. The *Primitive Methodists*, who are sometimes known as Ranters, originated in Staffordshire: their professed object is to recall the Wesleyans to the ancient spirit and fervour with which their fathers met rude and uncivilised mobs. By the census return the attendance on March 31, 1851, was, in the morning, 98,001; afternoon, 172,684; evening, 229,646: and in 1853, the return gave 1789 chapels. By their own report, of June 1860, they have 2267 chapels, and 3268 rented chapels and rooms, 675 travelling preachers, and 132,114 members in society. They have also 167,533 Sunday scholars, with 30,988 teachers. The report claims a considerable extension of the sect in every branch. Dissension in Leeds, in 1829, gave birth to the *Protestant Methodists*, who declared that the Wesleyans had violated their own laws by the erection of an organ in one of the chapels in that town, contrary to the decision of a leaders' meeting. In 1835, the establishment of the Theological Institution, the expulsion of Dr. Samuel Warren, and contentions on the rights of leaders' meetings, gave existence to the *Association Methodists*. In 1852 the Association had 329 chapels, and 171 rooms and other places for preaching, 90 itinerant ministers, 1016 local preachers, 1353 class leaders, and 19,411 members. Attendance on Census Sunday: morning, 32,308; afternoon, 21,140; evening, 40,565.

The *Wesleyan Reformers* separated formally in March, 1850, in consequence of the expulsion, by the Conference, of certain ministers, accused only of anonymous writings against the powers claimed by the Conference. At a meeting of delegates, in the month named, resolutions were passed, declaring that they approved of and adhered to the doctrines of John Wesley; and that they denied the right on any just or scriptural ground of the Conference to assume to be the sole legislative body. They also resolved that leaders and office-bearers should be chosen by the church; that admission into and expulsion from the church, and all disciplinary acts, should be determined by a leaders' meeting, subject to an appeal to the quarterly meeting; that the quarterly meeting should consist of all the travelling and local teachers, leaders, trustees, and stewards of the society; that the district meetings should consist of the travelling preachers of the district and of an equal number of lay representatives, to be chosen at the March quarterly meetings; and that the Connectional Committees should consist equally of preachers and lay members of the society. This secession it was estimated drew off 100,000 members from the parent stock; but a large body of the reformers having joined the Wesleyan Association in forming the United Methodist Free Church, the *Reform Union* numbers only about 60,000, with upwards of 3000 places of worship, about 3000 preachers, and 500 class-leaders. The attendance on Census Sunday, 1851, was—morning, 30,470; afternoon, 16,080; evening, 44,953. The report of the eleventh delegate meeting, held in October, 1859, states that there were then in the Union, 261 chapels, 186 preaching places, 873 preachers, and 118 on trial, 27 ministers, 1056 leaders, 17,088 members, and 1178 on trial, and 31,693 scholars.

The report of the third annual meeting of the *United Methodist Free Church*, held in July and August, 1859, states that in their Connexion there are 825 chapels, 422 preaching places, 163 itinerant preachers, 2522 local preachers, 2095 leaders, 50,133 members, and 3799 on trial, and 97,961 Sunday scholars.

(Reports of the Annual Conferences of the various sects, and the report of the registrar-general on *Religious Worship* after the Census of 1851, published in 1853.)

METHOL. A hydrocarbon constituent of wood naphtha. It is lighter than water, boils at 347° Fahr., and smells like spirit of turpentine.

METHYL; METHYLO; METHO. Prefixes used in chemical nomenclature to denote the presence of the radical methyl in the compounds to which they are applied. Thus methylconine signifies conine in which hydrogen is replaced by methyl. Such bodies, when of sufficient importance, will be found described under the name before which the prefix is placed, thus *methyl-urea* will be found under UREA, &c.

METHYL $\left(\left.\begin{matrix}C_2H_3\\C_2H_3\end{matrix}\right\}\right)$. An organic radical, homologous with ETHYL.

It is the lowest term in the series $C_n H_{n+1}$. Like ethyl it forms a very numerous class of compounds, but they have not been so completely investigated as those of the latter radical.

Methyl is obtained by acting upon iodide of methyl with zinc, in precisely the same way as described under the preparation of ETHYL.

Methyl is a colourless gas, of specific gravity 1·0305. It burns with a bluish, scarcely luminous flame, is almost insoluble in water, and only slightly so in alcohol. It is colourless and tasteless, and is not liquefied at a temperature of 0° Fahr. Neither concentrated sulphuric acid, fuming nitric acid, nor caustic potash, act upon it. It does not combine directly with oxygen, sulphur, or iodine, nor in the dark with chlorine; but when two volumes of the latter gas and one of methyl are exposed to diffused daylight, a mixture of hydrochloric acid gas and *monochlor-methyl* (C_2H_3Cl) is produced, no condensation occurring.

Hydride of methyl ($C_2H_4 = C_2H_3,H$). *Light carburetted hydrogen; Subcarburetted hydrogen; Formen; Marsh-gas*, or *Fire-damp*.

The last two are the names for this gas in its best known form. It sometimes issues, for months together, from a fissure in a coal seam, rushing forth as if escaping from under high pressure. "Blowers" is the name given by the miners to these natural discharges of fire-damp. They are sometimes so numerous in a mine that it could not be safely worked were it not for the use of the safety-lamp, discovered by Sir H. Davy. [LAMP, SAFETY.] By its means the miner is enabled to work in atmospheres that would be set fire to were his source of light a naked flame.

Hydride of methyl is also one of the gaseous exhalations from marshes and stagnant pools, and hence the name of *marsh-gas*. The bubbles of gas that rise to the surface when the mud at the bottom of a pond is stirred with a stick consist chiefly of marsh gas.

Hydride of methyl may be artificially prepared by strongly heating a mixture of four parts of crystallised acetate of soda, four of solid hydrate of potash, and six of powdered quicklime.

Hydride of methyl is colourless, inodorous, tasteless, and insoluble in water. Specific gravity 0·5596. Air containing a large per-centage of it may be inhaled, for almost any length of time, without producing the slightest apparent injury. It is inflammable, burning with a yellow, somewhat feebly luminous flame, the products of combustion being carbonic acid and water. For this combustion twice its bulk, or two volumes, of oxygen are necessary, one volume of carbonic and two of steam resulting. Inasmuch, however, as this oxygen is, in the case of colliery explosions, obtained from the air, and as moreover air only contains one-fifth of its bulk of oxygen (the remaining four-fifths being nitrogen, which alone cannot support life), it follows that the burning of fire-damp is immediately attended with the complete spoliation of ten times its bulk of air, the production of an equal quantity of suffocating gas, and the consequent vitiation of the whole atmosphere in the neighbourhood. The effect of such a state of things is, unhappily, only too well known to the miner, who fears the *after-damp*, or *choke-damp* as he calls it, perhaps more than he does the explosion itself.

Oxide of methyl (C_2H_3O,C_2H_3O). *Methylic ether*. This body corresponds to the ordinary ether, or correctly speaking ethylic ether, of the ETHYL series of compounds. It is also produced in a similar manner, namely, by submitting to distillation a mixture of methylic alcohol and sulphuric acid. Unlike ethylic ether, however, methylic ether is at ordinary temperatures a permanent gas. When cooled to 65° below the freezing point of water, by means of a mixture of snow and chloride of calcium, it condenses to a liquid, the boiling point of which is – 6° Fahr. (Berthollet). Its specific gravity is 1·617. It is inflammable, burning with a pale flame, is soluble in water to the extent of thirty-seven times its bulk, and still more soluble in alcohol. It is colourless, has an oppressive ethereal odour and pungent taste, properties also possessed by its solutions. From its formula it will be observed that methylic ether is isomeric with common alcohol; in vapour-density the two are also identical. Methylic ether dissolves in strong sulphuric acid, but is again evolved on dilution. Anhydrous sulphuric acid combines with it, and forms sulphate of methyl.

Oxide of methyl, like oxide of ethyl, combines with acids to form a class of ethereal salts, much resembling those described under ETHYL. They are also, for the most part, prepared in the same way. The following are the formulæ of a few of the principal ones: details concerning them will be found in the articles on the respective acids, under the name of *methylic derivatives* of the acid:—

Acetate of methyl (methyl-acetic ether)	$C_2H_3O, C_4H_3O_3$
Benzoate of methyl (methyl-benzoic ether)	$C_2H_3O, C_{14}H_5O_3$
Borate of methyl (methyl-boracic ether)	$3C_2H_3O, BO_3$
Butyrate of methyl (methyl-butyric ether)	$C_2H_3O, C_8H_7O_3$
Cyanate of methyl (methyl-cyanic ether)	C_2H_3O, C_2NO
Cyanurate of methyl (methyl-cyanuric ether)	$3C_2H_3O, C_6N_3O_3$
Formiate of methyl (methyl-formic ether)	C_2H_3O, C_2HO_3
Hyponitrite of methyl (methyl-nitrous ether)	C_2H_3O, NO_3 ?
Nitrate of methyl (methyl-nitric ether)	C_2H_3O, NO_5
Oxalate of methyl (methyl-oxalic ether)	$2C_2H_3O, C_4O_6$
Salicylate of methyl (methyl-salicylic ether)	$C_2H_3O, C_{14}H_5O_5$
Sulphamate of methyl (sulphamethylane)	$C_2H_3O, NH_2(SO_2)O_2$
Sulphate of methyl (methyl-sulphuric ether)	C_2H_3O, SO_3
Valerate of methyl (methyl-valeric ether)	$C_2H_3O, C_{10}H_9O_3$

Butyrate of methyl has an odour resembling that of the rennet apple. Oxalate of methyl is solid at ordinary temperatures. Salicylate of methyl is identical with oil of wintergreen. [ESSENTIAL OILS.]

Chlorine derivatives of oxide of methyl. Chlorine acts upon methylic ether, and successively removes and replaces one, two, and three equivalents of hydrogen; mono-, bi-, and per-chlorinated bodies being formed ($C_2H_2Cl,O : C_2HCl_2,O : C_2Cl_3,O$).

Hydrated oxide of methyl (C_2H_3O,HO). *Methylic alcohol; Wood spirit; Pyroxylic spirit*. This liquid is a strict homologue of vinic alcohol. Its source is the aqueous portion of the volatile products of the destructive distillation of wood. [CHARCOAL; ACETIC ACID.] After rectification from lime it is sent into commerce under the name of *wood naphtha*. The latter liquid, however, in addition to methylic alcohol, contains acetate of methyl and some oily hydrocarbons. To purify it from the acetate it is rectified from caustic soda, and the distillate having been digested with chloride of calcium (which combines with the methylic alcohol and forms a non-volatile salt), the hydrocarbons are got rid of by a second distillation, at a heat of 212°; water being now added to the salt, decomposition takes place, and the aqueous methylic alcohol separated by distillation is finally obtained pure and anhydrous on being re-rectified from lime.

Hydrate of methyl is a colourless liquid, of specific gravity 0·798 at 69° Fahr. It has an unpleasant burning taste, and an empyreumatic odour. When absolutely pure, however, its odour is rather agreeable than otherwise. It is readily soluble in water, alcohol, or ether. It burns with a pale flame, resembling that of alcohol. Its boiling point is 142° Fahr. When pure it gives no cloudiness on mixing with water, nor does it give a black precipitate of metallic mercury when added to a solution of mercurous nitrate. It dissolves the solid alkalies, but is immediately coloured brown by them, a reaction that distinguishes it from ethylic alcohol, which is not so coloured until after the lapse of considerable time.

The chief use of crude woodspirit in the arts is for dissolving shellac, and other resins, the solutions thus formed being largely used in HAT MANUFACTURE. For this and other purposes, however, *methylated spirit* is now commonly used; it is a mixture of spirit of wine of fifty per cent. over-proof, with one-ninth of its bulk of woodspirit.

The strength of woodspirit may be conveniently estimated by a hydrometer. The annexed table, by Deville, shows what per-centage of anhydrous methylic alcohol is contained in woodspirit of given specific gravity, at a temperature of 48·2° Fahr.:—

Sp. gr.	Wood spirit in 100 parts.	Sp. gr.	Wood spirit in 100 parts.
0·8070	100	0·9429	40
0·8371	90	0·9576	30
0·8619	80	0·9709	20
0·8873	70	0·9751	10
·9072	60	0·9857	5
0·9232	50		

Heated with potash-lime, methylic alcohol is converted into formiate of potash, with disengagement of hydrogen. Oxidising agents also give formic acid, and sometimes an intermediate body resembling an aldehyde. Malaguti calls this body *methylal* ($C_6H_8O_2$), and shows that the *formo-methylal* of M. Dumas is a mixture of methylal and formiate of methyl. When potassium is added to methylic alcohol, hydrogen is evolved, and *methylate of potash* (C_2H_3O,KO), corresponding to the ethylate of the same base, is formed.

Sulphides of methyl. In composition, properties, and mode of formation, these bodies closely resemble the corresponding ETHYL compounds. Methyl-mercaptan (C_2H_3S,HS) boils at 69·8° Fahr.; sulphide of methyl (C_2H_3S,C_2H_3S) at 105·8°; and bisulphide of methyl ($C_2H_3S_2, C_2H_3S_2$) at about 242°. There also appears to exist a tersulphide of methyl ($C_2H_3S_3,C_2H_3S_3$).

Chloride of methyl (C_2H_3Cl).—This is produced from wood spirit in the same way that chloride of ethyl is obtained from spirit of wine. At ordinary temperature it is a colourless gas, of ethereal odour and sweet taste, specific gravity 1·736. When cooled to −33° Fahr., it condenses to a liquid, the boiling point of which is about −6° Fahr. By the prolonged action of a dilute solution of potash upon chloride of methyl Berthollet has obtained methylic alcohol, and as chloride of methyl results from the action of chlorine on hydride of methyl, and hydride of methyl may be directly obtained from its elements, it follows that wood spirit, like most of the other alcohols, may be produced artificially.

By the action of chlorine upon chloride of methyl there are successively produced *chloride of chlormethyl* (C_2H_2Cl, Cl), *chloride of bichlormethyl* (chloroform) ($C_2H\,Cl_2, Cl$), and *chloride of perchlormethyl* (C_2Cl_2, Cl). The latter is identical with bichloride of carbon. *Chloride of nitro-perchlormethyl* ($C_2Cl_2(NO_4), Cl$) is CHLOROPICRINE.

Bromide of methyl (C_2H_3Br) is made by a similar method to bromide of ETHYL. Its specific gravity is 1·664; boiling point about 55° Fahr. *Bromide of bibrom-methyl* (C_2HBr_2, Br), or bromoform, is produced by the simultaneous action of caustic potash and bromine upon woodspirit, alcohol, or acetone. The *bromide of nitro-perbrom-methyl* ($C_2Br_2(NO_4)$ Br) is *bromopicrine.*

Iodide of methyl (C_2H_3I) is made in the same way as, and much resembles, iodide of ethyl. Its specific gravity at 72° Fahr. is 2·237. Boiling point between 105° and 120°. From iodide of methyl there are obtained by substitution processes the following compounds:—*Iodide of bichlormethyl* (C_2HCl_2, I) or CHLORIODOFORM; *Iodide of bibrom-methyl* ($C_2H\,Br_2, I$), or BROMIODOFORM; *Iodide of bi-iod-methyl* ($C_2H\,I_2, I$), or IODOFORM. By distilling iodoform with sulphide of mercury, Bouchardat has obtained an oily body which he calls *sulphoform*, but it has not yet been thoroughly investigated. A *cyanide of bi-iod-methyl* ($C_2H\,I_2,Cy$) has also been described.

Nitrides of methyl. [ORGANIC BASES.]

Cyanide of methyl ($C_2H_3\,Cy$), *Acetonitrile* or *acetonitryl.*—Prepared by distillation, from a mixture of sulphomethylate of potash and cyanide of potassium. Boiling point 170°·6 Fahr. *Cyanide of trichlormethyl* (C_2Cl_3Cy) is identical with *chloracetonitrile.*

Carbonate of methyl ($2C_2H_3O, C_2O_4$) has not been prepared, but *methylcarbonic acid* or *carbomethylic acid* (C_2H_3O, HO,C_2O_4) in the state of a baryta salt (C_2H_3O, BaO, C_2O_4) is precipitated when carbonic acid is passed through a solution of baryta in wood spirit.

Metallic methides.—This series of bodies is not quite so complete as the corresponding series of *ethides.* [ETHYL.] They are in nearly all cases produced by methods similar to those for obtaining the respective metallic ethides. For a description of them, see ORGANO-METALLIC BODIES.

Methyl-hexyl ($C_{14}H_{16}=C_2H_3, C_{12}H_{13}$) *Methylide of hexyl.*—This is a double alcohol radicle, containing methyl, united with hexyl—the radical of CAPROIC ALCOHOL. Its boiling point is 179°·6 (?) Fahr., and its vapour density 3·426.

Methylene (C_2H_2) is a gaseous body, obtained on passing chloride of methyl through a red-hot porcelain tube, hydrochloric acid being produced at the same time. It cannot, like ethylene, be formed by the action of hot concentrated sulphuric acid on the alcohol.

The following are the names and formulæ of the remaining more important compounds of methyl. Those containing nitrogen will be described in detail under ORGANIC BASES.

Methylamine	$N\left\{\begin{matrix}C_2H_3\\H\\H\end{matrix}\right.$
Dimethylamine	$N\left\{\begin{matrix}C_2H_3\\C_2H_3\\H\end{matrix}\right.$
Trimethylamine	$N\left\{\begin{matrix}C_2H_3\\C_2H_3\\C_2H_3\end{matrix}\right.$
Tetramethylammonium, hyd. ox.	$N\left\{\begin{matrix}C_2H_3\\C_2H_3\\C_2H_3\\C_2H_3\end{matrix}\right\}O, HO$
Trimethylphosphine	$P\left\{\begin{matrix}C_2H_3\\C_2H_3\\C_2H_3\end{matrix}\right.$
Tetramethylphosphonium, hyd. ox.	$P\left\{\begin{matrix}C_2H_3\\C_2H_3\\C_2H_3\\C_2H_3\end{matrix}\right\}O, HO$
Methyl-aniline (methyl-phenylamine)	$N\left\{\begin{matrix}C_{12}H_5\\C_2H_3\\H\end{matrix}\right.$
Methylcinchonine hydrate	$C_{40}H_{22}(C_2H)_2N_2O_2, HO$
Methylconine	$N(C_{16}H_{14})(C_2H_3)$
Methylcyanamide. [CYANAMIDE.]	
Methylmorphine	$C_{34}H_{18}(C_2H_3)NO_6$
Methylnicotine	$N(C_{10}H_7)(C_2H_3)$
Methylphenidine. [ANISIDINE.]	
Methylpiperidine	$C_{10}H_{10}(C_2H_3)N$
Methylquinine	$C_{40}H_{23}(C_2H_3)N_2O_4$
Methylsalicylate of methyl	$C_{14}H_4(C_2H_3)(C_2H_3)O_6$
Methylsulphurous chloride	$\left.\begin{matrix}C_2H_3\\Cl\end{matrix}\right\}S_2O_4$
Bichloromethylsulphurous chloride	$\left.\begin{matrix}C_2HCl_2\\Cl\end{matrix}\right\}S_2O_4$
Trichloromethylsulphurous chloride	$\left.\begin{matrix}C_2Cl_3\\Cl\end{matrix}\right\}S_2O_4$
Methylthiosinnamine	$NH_2(C_2H_3)\left(\begin{matrix}C_6H_5\\CyS\end{matrix}\right\}$
Methylurea	$\left.\begin{matrix}NCyH_3O\\C_2H_3O\end{matrix}\right\}$
Dimethylurea	$\left.\begin{matrix}NCyH_2(C_2H_3)O\\C_2H_3O\end{matrix}\right\}$

Acids.

Methylcamphoric acid. [CAMPHOR.]	
Methylcarbamic acid. [CARBAMIC ACID.]	
Methyldisulphocarbonic acid	$C_2S_4\left\{\begin{matrix}C_2H_3O\\HO\end{matrix}\right.$
Methyldithionic acid (methylsulphurous acid).	
Methylmalic acid	$C_8H_3(C_2H_3)O_{10}$
Methyloxalic acid	$C_4O_6\left\{\begin{matrix}C_2H_3O\\HO\end{matrix}\right.$
Methylselenious acid	$Se_2O_4\left\{\begin{matrix}C_2H_3O\\HO\end{matrix}\right.$
Methylparatartric acid	$C_8H_5(C_2H_3)O_{12}$
Methylsulphophenic acid	$\left.\begin{matrix}C_{12}H_4(C_2H_3)O\\HO\end{matrix}\right\}S_2O_6$
Methylsulphuric acid	$\left.\begin{matrix}C_2H_3O\\HO\end{matrix}\right\}S_2O_6$
Methylsulphurous acid	$\left.\begin{matrix}C_2H_3O\\HO\end{matrix}\right\}S_2O_4$
Chloromethylsulphurous acid	$\left.\begin{matrix}C_2H_2ClO\\HO\end{matrix}\right\}S_2O_4$
Bichloromethylsulphurous acid	$\left.\begin{matrix}C_2HCl_2O\\HO\end{matrix}\right\}S_2O_4$
Trichloromethylsulphurous acid	$\left.\begin{matrix}C_2Cl_3O\\HO\end{matrix}\right\}S_2O_4$
Methyltartric acid	$C_8H_5(C_2H_3)O_{12}$
Methylxanthic acid (methyldisulphocarbonic acid).	

METHYLCAMPHORIC ACID. [CAMPHOR; *Camphomethylic Acid.*]

METHYL-CONINE. [CONINE.]

METHYL-HEXYL. [METHYL.]

METHYL-PHENIDINE. [ANISIDINE.]

METHYL-UREA. [UREA.]

METHYLAL ($C_6H_8O_4$). One of the products of the oxidation of methylic alcohol. It contains the elements of 3 atoms of methylic alcohol minus 4 atoms of water.

METHYLAMINE. [ORGANIC BASES.]

METHYLATED SPIRIT. A mixture of alcohol with 10 per cent. of wood naphtha, allowed by the Excise to be sold duty free for manufacturing purposes. [ALCOHOL.]

METHYLENE. [METHYL.]

METOLUIDINE ($C_{14}H_8CyN$). A cyanogen derivative of toluidine. [ORGANIC BASES.]

METONIC CYCLE. [METON, in BIOG. DIV.]

METOPE. [ALTO RELIEVO.]

METRE (from the Greek *μέτρον, a measure*) is that quality of verse by which it is to the ear distinguishable from prose. It is frequently held to be one of the essentials of poetry; imaginative thought being the other. No reason can be assigned for this opinion, the truth being that it is attributable only to our nature as men, by which we feel pleasure in rhythmical arrangement of words, and consistently with which we cannot consider imaginative writing as perfect, unless couched in metre.

A distinction has been drawn between ancient and modern metres, one being said to depend on quantity, the other on accent; quantity and accent being further supposed to differ in kind. A little reflection however will tend to convince us that delicacy of ear has as much to do with the difference between ancient and modern metres as any fancied change from quantity into accent.

The southern nations still retain this delicacy of ear, as we know from the marked difference in Italian between the pronunciation of double and single consonants, a difference to which our language is a stranger as far as *time* is concerned. Though *we* see no distinction in time between the second syllable of the words *laborare* and *liberare*, there is no reason why the Romans should not; and with that assumption the whole difference between accent and quantity vanishes. It would be useless to enumerate the names which have been given to metres. The Greek and Roman metres differ from our own in being more numerous, and in allowing collocations of syllables (called feet) such as we could scarcely feel to be consonant with rhythm. The cause of this difference seems to lie in the form of each language.

Another grand distinction between ancient and modern metres is that of rhyme, which occurs but seldom in the former, and which, until the time of Shakspere, was nearly universal in the latter. Ancient and modern languages both afford specimens of the alliterative measure. [ALLITERATION.] Those who seek for further information on the subject of English metres, particularly on peculiarities which have occasioned so much difficulty to the readers of Chaucer, will do well to consult Mr. Guest's 'History of English Metres.' Some observations by Coleridge, prefixed to 'Christabel,' are also worth attention.

METRONOME (from *μέτρον, a measure*, and *νόμος, a division; also, a song*), an ingenious instrument; a pendulum, the point of suspension of which is between the extremities, invented and introduced about the year 1814 by John Maelzel (civil engineer, and mechanician to the emperor of Austria), for the purpose of determining the movement—that is, the quickness or slowness—of musical compositions.

Of the utility of a *time-measurer*, both to composers and performers, and for some account of its early use, see CHRONOMETER.

Of Maelzel's Metronome there are two kinds. The one is a pendulum kept in motion by a spring and wheelwork, and which ticks the vibrations:—the other is also a pendulum, as above described, but without any machinery, and acting so long as the force of the impulse given shall last. The former, therefore, it will be obvious, is complicated and expensive; the latter is simple and cheap.

The inventor thus describes and explains the manner of using this instrument:—

"1. A sliding weight is attached to the rod (which is graduated) or steel pendulum; the higher up this weight is shifted, the slower will be the vibrations; and *vice versâ;* so that when the weight corresponds with the number 50, the vibrations will be the slowest possible; at No. 160 they will be the quickest.

"2. These numbers have all reference to a *minute of time;* that is, when the weight is placed at 50, fifty beats or ticks will occur in each minute; when at 60, 60 beats, or seconds exactly, in a minute; when at 100, 100 beats in a minute, &c.; any stop-watch, therefore, will show how far the correctness of the metronome may be depended on.

"3. The doubles of the numbers of the scale answer to a precisely *double* degree of velocity. Thus, if 50 be the proper number for a minim, 100 will be the number for the crotchet *in the same movement*, &c. The numbers omitted on the scale have been found practically unnecessary.

"4. The composer is best able to judge, from the nature of his movement, whether to mark its time by minims, crotchets, quavers, &c. Generally speaking it will be found, that in *adagios*, it is most convenient to mark the time on the Metronome by quavers; in *andantes* by crotchets; in *allegros* by minims, and in *prestos* by whole bars. As often however as the case may admit, it is desirable that the pendulum should be made to beat integral parts of a bar, just as a master would beat or count the time."

Much opposition was made to the use of this excellent instrument, when first introduced; but no sensible composer or performer now entertains a doubt of the usefulness of the Metronome, or of some kind of pendulum answering the same purpose.

METROPOLIS. [COLONY.]

METROPOLITAN. [ARCHBISHOP.]

MEXICAN ARCHITECTURE. The ancient architectural remains in the Valley of Mexico, and in the adjacent countries, have never yet been examined with sufficient care and patience by a competent architect, or archæologist, to enable us to speak with any approach to certainty of their relative antiquity, or to characterise distinctly their essential peculiarities of age and style. Those who have visited and described them have been, for the most part, chiefly interested in discovering points of resemblance or dissimilitude with other ancient edifices, as those of Egypt, India, Greece, or even, as in the case of Lord Kingsborough, Jerusalem. Mexican architecture is that of two distinct people: the Tolteks, who occupied Mexico prior to the 7th century of our era; and the Azteks, with whom may be associated the Chichemacas, who inhabited the country at the Spanish conquest early in the 16th century. That which is believed to belong to the earlier race is also the most remarkable; the later would seem to have been derived from it. Architecture in its essential features similar to that of the Tolteks exists in various parts of Central America, and may be associated with it. As far as our present knowledge extends, the architecture of Mexico is to be regarded as, in the main, self-developed, rather than borrowed from that of any other country. The buildings display vast labour, and often considerable skill; but, whether regarded as constructive works or as works of art, they are at best the productions of a barbarous people. Yet, in their way, they are works of singular interest, and will repay a far more thorough investigation than they have yet received.

As in almost every other national architecture, the most important edifices are those devoted to the purposes of religion. These are known as Teocallis, and appear, like the Egyptian temples, to have contained apartments for the priests; they also contained sepulchral chambers, and had descending galleries leading down into caverned recesses or halls, which are variously conjectured to have been used for religious mysteries, or as places for the concealment of treasures, but may probably have been used for both purposes. In plan, these buildings are square; in form pyramidal, generally rising in successive storeys or stages, like a series of truncated pyramids placed one above another, each successive one being smaller than the one on which it immediately rests, so that it stands upon a platform or terrace; the holy place, or temple proper, being built on the summit, and subordinate in effect to the pyramid. The sides of the pyramids face the cardinal points; their angle of inclination is seldom less than 70 degrees, which differs little from that of the pyramids of Egypt.

The largest, most sacred, and best known of these Teocallis is that of Cholula, for which a fancied prototype has been found in the Temple of Belus, as described by Herodotus. This pyramid-temple of Cholula is now in appearance little more than a vast mound of earth covered with vegetation, and crowned with a small church. But on near inspection its architectural features are sufficiently distinguishable. The base of this huge structure measures 1440 feet each way (some authorities say 1488 feet); its height is 177 feet: the sides of the base of the great pyramid of Gizeh are only 763 feet, so that the area of the Mexican pyramid is nearly four times that of the greatest of those of Egypt, but it is not a third of the height. The body of the pyramid is formed of clay and sun-dried bricks. It consists of four terraces; and on the summit is a small church dedicated to the Virgin, which occupies a temple of the Toltek god of the air. From the perishable material of which it was constructed, its decorative features have all disappeared, and but a very imperfect notion can be formed of its original appearance. It contains spacious sepulchral cavities; and a square chamber formed of stone and supported by beams of cypress wood was some years back discovered in it. Within this chamber were two skeletons and several painted vases.

The buildings outside the limits of the valley of Mexico, and especially those in Central America, are in far better preservation. One of the most stupendous monuments of this style of architecture occurs at Palenque, near the eastern extremity of the present republic of Mexico. The great Teocalli at Palenque (built, according to the startling assumption of Lord Kingsborough, after the model of the temple of Solomon) comprised within its extensive precincts various sanctuaries and sepulchres, courts and cloisters, subterraneous galleries, and cells for the habitation of the priests. The whole rests on a platform, composed of three graduated terraces, and forms a spacious quadrangle inclosed by porticoes. On each side of the exterior is an ascent or flight of stairs, and on the east a second flight leading down, after the first is ascended, into the cloistered court. Beneath the cloisters are what are conjectured to have been initiatory galleries; and in the centre of the quadrangle is what appears to be the ruins of an altar or "high place." The temple itself is oblong in plan, 76 feet wide by 26 feet deep, and is decorated with sculpture and hieroglyphics executed in stucco. The roof is formed by graduated courses of stone, which meet at the summit, and has six ornamental projections, placed above the openings formed by the supporting piers, which were probably intended to support small idols or ornamental figures. The city of Palenque itself exhibits a variety of buildings, temples, palaces, baths, and private houses, all manifesting excellence of workmanship combined with considerable skill in design.

The palaces, or houses of the kings, appear to have resembled the temples in being based on pyramidal substructures; but these are generally oblong instead of square in plan, and much lower than the temple-pyramids. Their substructure is usually of stone, and very massive, elaborately sculptured with figures of idols and masks of monstrous proportions, scrolls, mat-work, &c., often executed with great skill. The upper part appears to have been of wood, but has mostly perished. One of the most characteristic of these is the palace at Mitla, the remains of which show that it must have been an edifice of great extent and grandeur. It appears to have originally comprised five distinct portions, which have been regarded as places of retirement for the kings, or as tombs. Three of these still remain. The principal one is nearly 130 feet long. A staircase leads to a subterranean apartment 88 feet by 26, the walls of which, like the exterior, appear to have been sculptured or tooled, in imitation of mat or basket-work—a species of decoration characteristic of Toltecan taste, and often found in sepulchral chambers. This same building has also a spacious hall supported by six plain cylindrical columns of porphyry, without base or capital, and in some respects differing from any found elsewhere. The ceiling which they support is formed of beams and slabs of cypress or savin wood of large size. Over the principal entrance is a stone lintel 12 feet long and 3 feet deep. There is no appearance of windows. The interiors of the chambers have been elaborately painted with representations of sacrifices, trophies, weapons, &c.; and with ornaments resembling those found in Etruscan decorations. Other palaces, especially those in Central America, that at Zayi for instance, have the terraces presenting successive architectural façades instead of mere flights of steps. Some instances, as the Casa de las Monjas, at Uxmas, occur where the buildings have been arranged around a central courtyard.

At Teotihuacan, about 8 leagues to the north-east of the city of Mexico, are several hundred small pyramids, ranged in files or lines, and two larger ones, which are believed to have been consecrated to the sun and moon. Each of the latter is divided into four platforms, the slopes between which consisted of steps, and on the summit was a colossal stone statue covered with plates of gold, which were stripped off by Cortes's soldiers, and the statues themselves destroyed.

Besides monuments which are chiefly works of magnificence, others exist which attest the high degree of civilisation attained by the Toltecans, such as roads and bridges. The former of these were constructed of huge blocks of stone, and frequently carried on a continued level, so as to be viaducts across valleys. There are also throughout Central America numerous excavations or rock-hewn halls and caverns, called by the natives "granaries of the giants." They resemble the Pelasgic fabric near Argos known by the name of the Treasury of Atreus, are generally dome-shaped, and the central apartment is lighted through an aperture in its vault. Other points of resemblance to Pelasgic masonry may be found in the doorways to these subterraneous galleries and apartments, which are to some extent similar to the gate of Mycenæ; and also in the peculiar triangular arch formed by courses of stones projecting over each other. Arches of this mode of construction are found in the cloisters of the building at Palenque. There are also extensive works for defensive purposes, earthen sepulchral mounds, &c. The remains of sculpture found in Mexico are numerous, and of great variety both of form and material.

(Lord Kingsborough, *Antiquities of Mexico;* Stephens, *Central America*, and *Yucatan;* Catherwood, *Ancient Monuments, Central America;* Fergusson, *Handbook of Architecture*, vol. i.; Gailhabaud, *Monumens Anciens et Modernes*, tom. iv.)

MEZEREUM, OR DAPHNE MEZEREUM, Spurge-olive, is an indigenous shrub; the bark obtained, in spring, from the root, is officinal. It is covered by a thin epidermis, green within, brown without. It is destitute of smell, but has a very acrid pungent taste, lasting for hours, and causes vesications. Its virulence even amounts to a poisonous degree, but is said to be lessened by camphor.

In the 'London Pharmacopœia' it only enters as an ingredient into the decoction sarsap. comp. It consists of an acrid resin, and an acrid volatile oil, and daphnin, which is not active. [MEZEREON, in NAT. HIST. DIV.]

The bark yields its properties to water, and still more perfectly to vinegar. The simple decoction of the 'Edinburgh Pharmacopœia' certainly possesses considerable power. Mezereon in a small dose acts upon the secretions of the salivary glands, the mucous membranes, the kidneys, and the skin. It also rouses the nervous energy of the brain, as its action in many cases of coma and stupor proves.

It may be employed locally to stimulate the salivary glands, or to remove paralysis of the mouth or throat; when so employed it is to be chewed, but the saliva must not be swallowed, as its acrimony causes inflammation of the stomach and intestines; and this may even be fatal from the hæmorrhage, vomiting, and purging which attend it. The berries swallowed incautiously produce the same bad effects.

The simple decoction, along with carbonate of ammonia, given in proper doses every two or four hours, has in several instances rescued patients from a state of imminent danger in the stage of collapse of typhus fever, or that of coma and effusion at the base of the brain, which sometimes occurs in scarlet fever. In torpor of the brain, in leuco-phlegmatic subjects, and in approaching amaurosis, it is also of use. It has also been found serviceable in chronic rheumatism and chronic cutaneous diseases. A portion of the bark macerated in vinegar and applied to the skin, forms a powerful vesicant. [DAPHNE, in NAT. HIST. DIV.]

MEZZANINE (Italian, *Mezzanini*), in architecture, a low storey between two higher ones: the same as ENTRESOL.

MEZZOTINTO, in engraving, a peculiar mode of engraving designs of any description upon plates of copper or steel, with the view of obtaining impressions therefrom. In this style of engraving, which essentially differs from every other, the surface of the plate is first indented or hacked all over by the action of an instrument something like a chisel, with a toothed or serrated edge, called a *cradle*, or mezzotinto *grounder*. This tool being rocked to and fro in many directions, indents or barbs the plate uniformly over its face, and produces what is called the mezzotinto grain or ground.

The barb, or nap, thus produced retains the printing ink; and if in this state of preparation an impression were taken from the plate upon paper, it would be uniformly of a deep black colour.

The directions, or *ways*, as they are technically called, given to the grounding-tool, are determined by a regulated plan, and for this purpose an ingenious sort of scale is used which enables the workman to pass over the plate in almost any number of directions without repeating any one of them. The mezzotinto ground being thus laid, it is at this period that the business of the artist properly commences. Having traced or drawn, with a pencil or other instrument, his outline upon the paper (unless indeed, as is sometimes the case, this should have been etched by the ordinary process, previous to the mezzotint ground having been laid), he proceeds to remove the nap or ground, in conformity with the design, from all those parts which are not intended to be perfectly black in the impression. The instruments required for this purpose are scrapers and burnishers; with the former he scrapes away more and more of the ground in proportion to the brightness of the light, and the burnishers are used to produce perfect whiteness where it is required, as the high lights on the forehead or tip of the nose, or white linen in a portrait, &c. As the work proceeds it may be blackened with ink, applied with a printer's ball or otherwise, to ascertain the effect; after which the scraping may again be proceeded with, the artist taking care always to commence where the strongest lights are intended to appear.

The great facility with which mezzotintos are executed, as compared with line-engravings, will be obvious, seeing that it is much easier to scrape or burnish away parts of a dark ground corresponding with any design sketched upon it, than it is to form shades upon a white ground by an infinite number of strokes, hatches, or points, made with the *graver* or *etching-needle*. Herein consists the leading difference between this and all other modes of engraving; for while the process in each of these is invariably from *light* to *dark*, in mezzotinto it is from *dark* to *light*; and even the very deepest shades are produced, as we have seen, before the design is commenced. The characteristic or distinguishing excellence of mezzotinto engraving would seem to consist in the richness, depth, mellowness, and harmony of its shadows, the obscurity of which especially sympathises with fine effects of chiaroscuro.

Having mentioned what we conceive to be the characteristic excellence of mezzotinto, namely, the richness and profundity of its shadows, it is but fair to add that its chief defect seems to be a corresponding poverty in the lights; and this objection will be felt to have much weight, when it is considered that it is to the lights in a picture that the eye is invariably attracted. On the lights therefore the line-engraver displays all that delicacy and beauty of line which agreeably irritates the eye and compensates for the absence of colour, by rendering the lights more interesting than the shadows. The lights in mezzotinto, on the contrary, where they occur in broad masses, have been ever felt by the judicious to be comparatively cold and poor. This objection has been partly obviated by a judicious admixture of *etching* with the mezzotinto, which, by enriching the lights, has done much towards uniting the energies of both styles. Objection has also been taken to mezzotinto on account of the limited number of good impressions which an engraving in this style would yield, in consequence of the very superficial nature of the ground. A work of this sort, however, was always more susceptible of renovation by retouching than one produced by any of the other modes; and the introduction of steel plates, which are now commonly substituted for those of copper, has removed the objection almost entirely, a very large number of good impressions being thus ensured without the necessity of retouching. A copper-plate will seldom furnish above one hundred and fifty good prints before requiring retouching. When the plate begins to wear, the practice is to work it over again, partially, with the cradle, and afterwards to again have recourse to the scrapers; and in this way impressions of fifty at a time may be taken; so that by alternately retouching and printing by fifties, five hundred prints are frequently obtained from one copper-plate. But from a *steel*-plate eight or ten times that number may be obtained. The process is the same in the one case as in the other, but heavier *pressure* on the grounding-tool is requisite on a steel-plate. A greater number of *ways* also is desirable, and these may be effected without rendering the subsequent engraving liable to more rapid deterioration, as would be the case upon copper. As many as ninety *ways* are frequently used on steel, while the number on a copper-plate varies from twenty-four to forty, which latter is rarely exceeded.

The discovery of the art of engraving in mezzotinto has been a subject of some controversy. The account commonly given of its discovery is, that Prince Rupert observed one morning a soldier engaged in cleaning from his musket the rust which the night-dew had occasioned, and perceiving upon it, as he thought, some resemblance to a figure, it occurred to him whether or not, by corroding or grounding a plate all over in a manner resembling the rust, he might not afterwards scrape away a design upon it, from which impressions might be obtained. He tried, it is said, and succeeded, and thus became the inventor of mezzotinto engraving. The merit of the discovery was claimed in the 'Parentalia,' p. 214, for Sir Christopher Wren, on the ground of a communication which he made to the Royal Society in 1662, the Journals of which society for October in that year record that "Doctor Wren presented some cuts, done by himself in a new way, whereby he could almost as soon do a subject upon a plate of brass or copper as another could draw it with a crayon upon paper." This claim is however disposed of by the fact that the principal mezzotinto by Prince Rupert, the 'Decollation of St. John the Baptist,' after a design by Spagnoletto, bears date 1658, which is four years earlier than Sir Christopher Wren's communication to the Royal Society; whilst Evelyn's 'Scalptura' (8vo, 1662), in which Rupert's "invention" is described and illustrated by an engraving executed by the prince, was presented to the Royal Society at the meeting of the 11th of June, 1662, or four months prior to Wren's communication. (Weld, 'Hist. of Royal Soc.,' i. 118.)

But while it is thus clear that the pretensions of Prince Rupert completely supersede those of Sir Christopher Wren, it is certain that those of Prince Rupert himself are invalid.

The real inventor of this art appears to have been Louis von Siegen (born 1609), a lieutenant-colonel in the service of the Landgrave of Hesse Cassel; and according to Baron Heneiken ('Idée Générale d'une Collection Complète d'Estampes,' 1771), Prince Rupert learnt the art from Von Siegen, whose first specimen made public was a portrait of the Princess Amelia-Elizabeth of Hesse. Proofs of this engraving of the first state bear the date 1642; of what is called the second state—of which there is a fine impression in the Print Room of the British Museum—the date is 1643, which is *fifteen years anterior* to the earliest of Prince Rupert's dates. In the same collection there are other prints by Von Siegen, one of which, if the external evidence were insufficient, would, we think, place the question beyond dispute; for, although without a date, it bears conclusive internal evidence of having been produced in the very infancy of the art, since it exhibits a total misconception or misapplication of its peculiar local powers, which, as we have said, are especially calculated for large masses of shadow of an indefinite character, such as a plain background to a portrait. The work to which we allude, which is a portrait of the Princess of Orange, the eldest daughter of Charles I., is a mixture of line-engraving and mezzotinto, and in it the background (which, if the mixed style be used, would be best effected by the mezzotint ground) is performed wholly in cross-hatches by the old process; while the flesh and even the hair, in which line-engraving might have been applied with advantage, are produced wholly by the new process of mezzotinto. Von Siegen's known mezzotinto plates are, we believe, in all only seven in number. There are also works by Theodore Caspar Fürstenburg, who probably learnt the art from Von Siegen, which bear date 1656, being earlier than anything by Prince Rupert; but the works both of Fürstenburg and Prince Rupert are engraved entirely by the newly discovered process of mezzotinto, and evince a more matured knowledge of its powers than those of its inventor Von Siegen. We will only further add the remarkable fact, that Von Siegen frequently attached the word "inventor" to his works, of which we subjoin an instance in the inscription to a 'Holy Family,' engraved by him after Carracci, and one of his latest performances: "Eminentissimo Principi Domino D. Julio Mazzarini, S.R.E., Cardinali, &c., novi hujus Sculpturæ modi *primus inventor* Ludovicus à Siegen humilissime offert, dicat et consecrat. A° 1657."

It is not improbable, however, that Prince Rupert, by himself or with the assistance of Wallerant Vaillaint, an artist whom he retained in his suite, may have improved the mechanical mode of laying the mezzotinto ground; and it should also be stated that there is by Sir Christopher Wren a head of a blackamoor, which is thought to have been done by a process differing from that of Prince Rupert. But these observations relate not to the principle of the art, but merely to the tool with which the *ground* is produced. The more perfect instrument at present used (that is, the *cradle*) is said by Bartsch to have been invented by Blooteling, a very skilful engraver in mezzotinto, who produced many of his works about 1672.

It is in our own country that mezzotinto engraving has been carried to the greatest perfection, and it attained excellence early in the last century. It was the favourite mode of Sir Joshua Reynolds, for whose style its painter-like breadth was singularly well fitted, and his patronage called forth a school of engravers who at once exhibited the full capabilities of the method. Nothing finer in their way can be desired than the long series of prints after Reynolds by James M'Ardell, Fisher, Dickinson, Richard Houston, Valentine Green, and the Watsons (Thomas, James, and Caroline); while, in a somewhat different way, Richard Earlom contributed more perhaps to the improvement and extension of this art than any one else, and whose works, embracing almost every class of subject (history, portrait, still life, &c.), are in almost every collection of importance in the country. The superiority thus acquired by the English mezzotinto engravers has been well maintained down to the present day, when, in Mr. Cousins, and others of scarcely less celebrity, we possess artists without equals among foreigners in this branch of art.

MIASMA is a Greek word (*μίασμα*) signifying pollution or corruption generally, and is employed to designate a certain volatile deleterious principle, arising either from the bodies of the sick, from animal or vegetable substances, or from the earth, and capable of exerting a morbid influence on those exposed to its action. To the terrestrial emanations the Italians have given the name of malaria (from *mala* and *aria*, bad air), and this word has been generally adopted into other languages. To those emanations which arise from the bodies of the sick, the term contagion is more properly applied. In common parlance, then, miasma is seldom employed to designate the contagious effluvium of disease, but, with the adjunct marsh, is restricted to the sense in which malaria is used: hence we speak of marsh miasma and malaria as one and the same thing. Though marshes, whether salt or fresh, are prolific sources of malaria, they are by no means the only sources; the mud which is left by the drying of extensive ponds and lakes, the half-wet ditches of fortifications, and neglected sewers and drains, are capable of furnishing this poison. The decomposition of vegetable matter, in other circumstances than in connection with soil, is likewise capable of producing it; this has been exemplified in the sickliness of ships from the leakage of sugar into a damp hold. Having enumerated some of the sources of miasma, the question naturally suggests itself.—What are the conditions essential to its development? The mere name of marsh miasma suggests the idea of stagnant water, and if the preceding enumeration of circumstances under which the production of malaria takes place be examined, it will be found that vegetable matter and moisture are present in all the examples, and that animal matter is so occasionally. But how great soever may be the share which moisture has in its production, it is certain that only a very small proportion is necessary. A marsh, the whole surface of which is thoroughly wet, is comparatively innocuous; but if partially or entirely dried by the summer's heat, it becomes extremely pestilential in autumn; indeed malaria, in its most intense degree, has been met with in low lands which had become as dry as a brick ground, with the vegetation utterly burnt up, and hence a high temperature seems to be another agent necessary, or at least favourable to its development. According to Dr. Ferguson, the only condition indispensable to the production of marsh miasma on all surfaces capable of absorption, is the paucity of water where it had previously recently abounded, a rule to which he assures us there is no exception in climates of high temperature. Of the chemical and physical properties of malaria nothing is known; even the very obvious question, whether it is always the same kind of poison, or whether a multiplicity of such poisons may not exist, is one which the present state of our knowledge does not enable us to answer. The occasional existence of putrefaction in conjunction with malaria is an accidental concomitant, but by no means essential to its activity as a poison. With regard to the effects of malaria, these manifest themselves in a longer or shorter period after exposure to its influence, and consist chiefly in the production of intermittent, remittent, and yellow fevers, dysentery, and typhus. The long-continued application of the same poison in a diluted form gives rise to various disorders of minor import, gradually undermines the constitution, and produces premature old age; even the inferior animals and vegetables partake of the general depravation which characterises malarious districts. The most efficient means of preventing the generation of the malarious poison, and, by consequence, the diseases to which it gives rise, are, the draining of swampy lands, and preventing the accumulation of putrid or putrescible vegetable or animal matter.

MICHAELMAS, the feast of St. Michael the archangel, 29th of September. Brady says it was first established in A.D. 487. Michaelmas-day is one of the regular periods, in this country, for settling rents; and an old custom is still in use of having a roast goose to dinner on that day, probably because geese are at this time most plentiful and in the highest perfection. There were formerly many superstitions connected with the observance of this day.

(Brand's *Popular Antiquities*, Sir H. Ellis's edit., 1841.)

MICROMETER (from *μικρὸς small*, and *μέτρον a measure*), the term generally applied to contrivances for measuring small spaces or angles with great accuracy or convenience.

The word is not applied to some artifices for subdividing the graduations of an astronomical instrument (for these see VERNIER), nor when a magnified portion of a subsidiary arc is used, which may be best considered under the heads of SECTOR, and ZENITH SECTOR, though they come properly under the definition. We shall follow the usual meaning of the term.

1. *Wire Micrometer.*—When the rays from any bright object fall upon a convex lens, an inverted image of the object is formed, which may be viewed by the eye-piece as if it were a material body. If a fine wire or spider's web be stretched across the telescope tube at the place where the image is formed, this too will be seen distinctly through the eye-piece. Instead of fixing the wire to the telescope tube, it is stretched across a sliding-piece, which is moved by a screw perpendicularly to the length of the telescope, and can thus be made to measure the image in terms of the revolutions and parts of the screw. The head of the screw is divided, and there is an index by which the parts are read off. A little tongue passing over the notches of a plate notes the whole number of revolutions.

An English gentleman named Gascoigne seems first to have applied this principle to practice, but he unfortunately lost his life, in 1644, in the great civil war; and though his telescope fell into Townley's hands, and was used by him, the construction does not seem to have been generally known until it was re-invented by Auzout in 1666. Different improvements were gradually made nearly up to the present time.

The plate carrying the wire is drawn by the screw, and held back by springs, which prevent any lost time. A micrometer of this kind is now generally applied to circles, transits, and theodolites, in addition to the fixed wires, which of course are always necessary. There are two verifications: first, the ascertaining the value of a revolution of the screw; and secondly, determining the reading of the screw-head when the moveable wire coincides with the fixed wire. In a circle or theodolite the micrometer wire is placed upon a sharp distant object, and the divided limb read off. The screw is turned through several revolutions, and the object is again bisected by moving the whole instrument by its tangent screw, and the divided limb read off a second time. We have then the same angle measured in revolutions of the screw and in the divisions of the instrument, and by a simple proportion have the value of a revolution and of a part. With a transit, the passage of Polaris over the micrometer wire is observed after successive revolutions of the screw. The angular motion of Polaris for the intervals is computed from the polar distance, and thus the value in arc obtained for a revolution of the screw. To determine the zero position of the micrometer wire, the moveable wire is brought to touch the fixed wire, first on one side and then on the other, and the screw-head read off each time. The mean of the two readings will be that when the two wires are exactly superimposed.

The *position wire micrometer* is much used for observations of double stars, and is the wire micrometer proper for equatorials. In this construction there are two wires parallel to each other, each moveable by its own screw: the whole apparatus can also be turned round in the plane of the wires, so as to place the wires in any direction, the angle round which it is turned being read off by two verniers upon a small circle called the *position circle*. In measuring a double star the wires are brought near each other, and the apparatus turned round until the two stars are either threaded on one of the wires, or, being placed between them, are judged to lie in the same direction. The division of the micrometer circle is then read off, and the observation in position is made. Now, by the divided circle of the micrometer turn the apparatus round 90°, and the wires will be at right angles to the line joining the two stars. By moving the equatorial, place one wire A on one of the stars, and place the other wire B, by its screw, on the second star. Read off the screw-head of B, and then place A on the second star by moving the equatorial, and B on the first by moving its screw, and read off the revolutions and parts of B. The difference of the two readings of B will give, in revolutions and parts of the screw, twice the angle between the two stars. The process may be repeated, keeping B fixed and moving A. Before or after a series of observations the zero or index error of the position circle should be ascertained. Place the instrument nearly in the meridian, and make a star run along one of the wires from end to end. Read and note the position circle, which should mark 90° and 270°, and the difference from this is the correction to be applied to all the angles of position observed during the evening. The value of a revolution of the screw may be determined by separating the two wires a given number of revolutions, and observing a series of transits of known stars over them. As large equatorials are always carried by a clock movement, we should recommend fixing the *position micrometer* upon a *slipping*-piece, by which a small motion up or down or to the right or left can be given to the wires without meddling with the clock or the equatorial. With this apparatus the measurement of double stars is perfectly easy. The wire micrometer requires illumination for seeing the wires, and the light thus admitted often obliterates faint and ill-defined objects.

The micrometer microscope, for reading off the divisions of graduated circles, depends upon the same principle as the wire micrometer. An enlarged image of the divisions of the limb of the circle is formed, and this image is measured by the revolutions and parts of a screw. [CIRCLE.]

2. The *divided object-glass micrometer* and *heliometer*. If an object-glass be cut across so as to form two semicircles, and the semilenses be separated by sliding one beyond the other, each portion will form its proper image, and these will retreat from each other as the semilenses are moved. The semilenses are mounted on slides, and the quantity of separation is read off upon a scale. In Bessel's heliometer, a very fine and perfect instrument of this class, the focal length of the object-glass is eight French feet, and the aperture nearly six French inches. A description and plate will be found in the 'Astronomische Nachrichten,' No. 189. The only objection which can be made to this species of micrometer, besides the extreme difficulty of constructing it, is, that stars are not seen so round and well defined as in an entire object-glass. Bessel's measures of double stars are, however, so far as we can judge, the most accurate that have yet been made. Suppose a double star is to be measured with the heliometer: the whole of the object end is turned round, until four stars appear in a right line, and the semilenses are separated until the stars appear to be exactly at the same distance from each other, when the scale is read off. The semilenses are then shifted in a contrary direction, sliding the two images over each other, until they again appear to be at equal distances, and the scale is again read off. The separation of the scale is four times the angular distance between the stars. There is a position circle, on which the direction of the stars is read off. In measuring the diameters of the sun, planets, &c., the two images are made to touch on opposite sides; and in observations of Halley's comet it was made to coincide with the neighbouring stars. The divided object-glass micrometer is on the same principle as the heliometer; a cap containing the divided lenses is placed over the object-glass of the telescope. A similar micrometer may be obtained by dividing one of the lenses of an eye-piece; and it seems probable that, with large telescopes, this micrometer may be of considerable use in measuring small angles. There is a good deal of colour in the images, but not at the point of contact. Micrometers of this class require no illumination.

3. *Reticle* and *circular micrometer*. The micrometers hitherto described are applied to the *accurate* measures of small angles; the present class, though very useful in certain cases, are of much lower pretensions. The reticle, or diaphragm, as it is sometimes called, is any fixed arrangement of wires or bars which can be applied to a telescope for the purpose of measurement. They are chiefly used when an object will not admit of illumination, or where the astronomer has no accurately divided instrument at his disposal, or, as in the case of La Caille at the Cape of Good Hope, when the object is to fix approximately a greater number of stars than could be done in the same time with ordinary instruments. Suppose a cross like an X or V to be cut out of brass-plate and inserted in the principal focus of a telescope with the axis of the letter in a meridian. A star in passing through the field is occulted at its passage behind each of the bars, and the time noted. The *interval* will show, by an easy calculation, how far it passes from the vertex; and the *mean* of the times, the moment when it passes the axis of the diaphragm. If the true position of any one star so passing is known from any other source, all the other stars can be thus determined differentially with respect to it. The method is not very accurate, but may often be applied advantageously and with very small instrumental means. If a fine wire be drawn perpendicular to the axis, and a bright star, observed with illumination, be made to run along the wire, the axis of the diaphragm can be set in a meridian, and that is the only verification necessary. The computation in declination will be least if the angle between the bars is such that the base of the triangle is equal to its altitude. This reticle is very convenient for mapping, if placed in the meridian, or for cometary observation, if the telescope is mounted as an equatorial, however rudely.

The circular micrometer was introduced, we believe, by Olbers, and perfected by Frauenhofer ('Astron. Nachricht.' iv. 22). A metal ring is set in the centre of a perforated glass plate, and the outer and inner edge of the ring is turned true. The plate is fixed in the focus of a telescope, and the appearance is that of a ring suspended in the heavens. The telescope is pointed, and the observer notes the time when a star disappears at the outer ring, re-appears on the inner ring, disappears again, and finally re-appears. If two stars be thus observed, it is clear that when a mean is taken of the disappearances and re-appearances of each, that the difference between the two means will be the difference of right ascension between the two stars, and therefore that if one be known, the other is determined. Again, if the diameter of the ring has been determined, and the declination of the stars nearly known, the time of describing the chord of the ring will give, by an easy computation, the distance of the chord from the centre, and that the more accurately the smaller the chord described. The sum or difference of these two distances is the difference of the stars in declination. The computation of the second star with its approximate declination may be repeated if the stars are near the pole. It will be seen that nothing is required for the circular micrometer but the power of fixing the telescope for a few minutes until a known star passes the field, and that no illumination is required. It is especially the apparatus for determining the place of a faint comet or planet, and in the hands of Olbers, Harding, and many other German astronomers, has been of infinite use in cometary astronomy, and in the discovery and observation of the small planets. When the comet has a large motion, or when the position of the star is so low as to require attention to the difference of refraction, the computation is a little more complicated, but generally scarcely any computation is required, and the results, in right ascension at least, are good. The observations at the inner edge of the ring are to be preferred. When however the object will bear illumination, and the astronomer possesses a telescope so mounted that he can apply a wire micrometer to it, the results from this are incomparably more accurate, and the reticle above mentioned is certainly better for determining declination. Frauenhofer afterwards ('Astronom. Nach.' iv. 43) proposed another ring and reticle micrometer. He cut a series of rings or lines upon a piece of plane glass which he placed in the principal focus of the object-glass, and then by a side lamp illuminated the rings, leaving the rest of the field dark. It is evident that for certain observations this micrometer would have great advantages.

There are many other micrometers, but they are not in such general use as to demand any notice here. The reader will find them very fully and elaborately described in Pearson's 'Practical Astronomy,' vol. ii. See also Herschel and South's 'Observations of 380 Double and Triple Stars' (pp. 22, 23), containing tables of the values of Troughton's screws.

Since the above article was written by the Rev. R. Sheepshanks, micrometry, like all other branches of science, has put forth new shoots. In the original micrometer of Gascoigne, nicely ground parallel edges of brass plate were used, and Dr. Hooke made the important improvement of substituting parallel hairs. Such an instrument embodies the principle of the best and most recent micrometers. The most difficult as well as important part of this instrument is the screw or screws by which the forks are moved. Their threads must not only be at the same distance from each other, but have their inclination equal all round. In the screw of Troughton's micrometer there are about 103 threads in an inch.

The usual method of finding the value of a revolution of the screw has been already given. The method of Professor Gauss of Göttingen is thus stated by Sir David Brewster ('Encyclopædia Britannica,' art. 'Micrometer'):—"He employs for this purpose a standard telescope, with a micrometer, the value of whose scale has been accurately determined. Since the wires of a telescope-micrometer adjusted to distinct vision of the stars or planets are accurately in the focus of parallel rays falling on the object-glass, it follows that rays issuing from the wires and falling on the inside of the object glass will emerge from it perfectly parallel. Now if we place the object-glass of the standard telescope close or near to that of the first telescope, the parallel rays formed by those issuing from its wires will be refracted to the focus of the standard telescope, and a distinct image of the wires will be there formed. The observer therefore when he looks into the standard telescope will see distinctly the wires of the first telescope, and by means of his micrometer he will be able to measure exactly the angular distance of these wires at whatever distance they may happen to be placed. This angular distance, divided by the revolutions and parts of a revolution which are necessary to bring the wires of the first telescope to the zero of their scale, will give the value of one revolution of the screw, or of one unit of the scale."

The parallel fibres of a micrometer must be extremely fine, and of uniform diameter. Since Hooke's time, wires and fibres of silk have been used instead of hairs. Troughton introduced the spider's line, which he found to be sufficiently fine, opaque, and elastic to answer the purpose: the stretcher, or long line which sustains the web, being alone adapted. The fibres of spun glass, of melted sealing-wax, of asbestos, and the minute crystals of mezzolite have also been used; but Wollaston's fine platinum wire [DUCTILITY] has of late years been preferred. These wires offer another advantage in the method of illuminating them, which in the transit instrument is generally done by means of a lamp, the light of which passes along the horizontal axis to a small speculum which reflects it upon the wire. The new method is to make the wires red hot by transmitting a voltaic current through them. Arago (who first adopted, if he did not first suggest the idea) feared that the images of objects beyond and apparently near the heated wire would undulate, but such was not found to be the case. This method of illumination has been used for the wires of the microscopic micrometers attached to the Oxford heliometer [HELIOMETER]. M. Porro's mode of illuminating the wires is to mount them on glass plates, the edges of which are formed into suitable curves, so as to introduce a thin vein of light perpendicularly to the axis of the telescope, so that the wires appear of a silvery white in a dark field. Brewster also proposed to obtain micrometer lines by placing in the field of view the reflected images of a fixed or moveable system of wires, or of lucid discs, attached to the side of the eye-piece. The same distinguished optician has also proposed what he calls *photographic micrometers*. The reader is of course aware of the ease with which microscopic photographs can be impressed upon a film of collodion—as many as 10,000 portraits having been introduced into a square inch. "If a system of opaque or transparent lines be impressed upon the collodion photographically, when reduced to the minutest size, from a system of large and sharply defined lines, we shall have the most perfect micrometrical scale that can be conceived, the portion of the collodion that contains no nitrate of silver being as transparent as if the dark spaces were solid wires or metallic plates, placed in the focus of the eye-glass."

The plan of opening and shutting a pair of parallel wires optically instead of mechanically, and of using it as a general principle in micrometers, has also been applied; but for the details we must refer to the treatise above quoted, in which will also be found minute details respecting various forms of double-image micrometers, in which two singly refracting lenses, semi-lenses, or prisms, are separated by screws, or where the two images are separated optically, or in which the two images are formed by double refraction, and many others.

For a description of micrometers for microscopes see MICROSCOPE.

MICROCOSMIC SALT (NaO, NH_4O, HO, PO_5). The tribasic phosphate of soda, water, and ammonia; a salt much used as a flux in blowpipe experiments. [BLOWPIPE.]

MICROSCOPE, the name of an instrument for enabling the eye to see distinctly objects which are placed at a very short distance from it, or to see magnified images of small objects, and therefore to see smaller objects than would otherwise be visible. The name is derived from the two Greek words, expressing this property, *μικρὸς*, *small*, and *σκοπέω*, *to see*.

So little is known of the early history of the microscope, and so certain is it that the magnifying power of lenses must have been discovered as soon as lenses were made, that there is no reason for hazarding any doubtful speculations on the question of discovery. We shall proceed therefore at once to describe the simplest forms of microscopes, to explain their later and more important improvements, and finally to exhibit the instrument in its present perfect state.

In doing this we shall assume that the reader is familiar with the information contained in the articles LIGHT, LENS, ACHROMATIC, ABERRATION, and the other subdivisions of the science of Optics which are treated of in this work.

The use of the term *magnifying* has led many into a misconception of the nature of the effect produced by convex lenses. It is not always understood that the so-called magnifying power of a lens applied to the eye, as in a microscope is derived from its enabling the eye to approach more nearly to its object than would otherwise be compatible with distinct vision. The common occurrence of walking across the street to read a bill is in fact magnifying the bill by approach; and the observer, at every step he takes, makes a change in the optical arrangement of his eye, to adapt it to the lessening distance between himself and the object of his inquiry. This power of spontaneous adjustment is so unconsciously exerted, that unless the attention be called to it by circumstances, we are totally unaware of its exercise.

In the case just mentioned the bill would be read with eyes in a very different state of adjustment from that in which it was discovered on the opposite side of the street, but no conviction of this fact would be impressed upon the mind. If however the supposed individual should perceive on some part of the paper a small speck, which he suspects to be a minute insect, and if he should attempt a very close approach of his eye for the purpose of verifying his suspicion, he would presently find that the power of natural adjustment has a limit; for when his eye has arrived within about ten inches, he will discover that a further approach produces only confusion. But if, as he continues to approach, he were to place before his eye a series of properly arranged convex lenses he would see the object gradually and distinctly increase in apparent size by the mere continuance of the operation of approaching. Yet the glasses applied to the eye during the approach from ten inches to one inch, would have done nothing more than had been previously done by the eye itself during the approach from fifty feet to one foot. In both cases the magnifying is effected really by the approach, the lenses merely rendering the latter periods of the approach compatible with distinct vision.

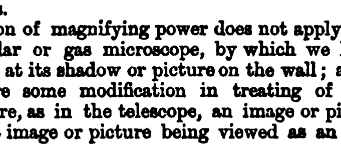
A very striking proof of this statement may be obtained by the following simple and instructive experiment. Take any minute object, a very small insect for instance, held on a pin or gummed to a slip of glass; then present it to a strong light, and look at it through the finest needle-hole in a blackened card placed about an inch before it. The insect will appear quite distinct, and about ten times larger than its usual size. Then suddenly withdraw the card without disturbing the object, which will instantly become indistinct and nearly invisible. The reason is, that the naked eye cannot see at so small a distance as one inch. But the card with the hole having enabled the eye to approach within an inch, and to see distinctly at that distance, is thus proved to be as decidedly a magnifying instrument as any lens or combination of lenses.

This description of magnifying power does not apply to such instruments as the solar or gas microscope, by which we look not at the object itself, but at its shadow or picture on the wall; and the description will require some modification in treating of the compound microscope, where, as in the telescope, an image or picture is formed by one lens, that image or picture being viewed as an original object by another lens.

It is nevertheless so important to obtain a clear notion of the real nature of the effect produced by a lens applied to the eye, that we will adduce the instance of spectacles to render the point more familiar. If the person who has been supposed to cross the street for the purpose of reading a bill had been aged, the limit to the power of adjustment would have been discovered at a greater distance, and without so severe a test as the supposed insect. The eyes of the very aged generally lose the power of adjustment at a distance of thirty or forty inches instead of ten, and the spectacles worn in consequence are as much magnifying glasses to them as the lenses employed by younger eyes to examine the most minute objects. Spectacles are magnifying glasses to the aged because they enable such persons to see as closely to their objects as the young, and therefore to see the objects larger than they could themselves otherwise see them, but not larger than they are seen by the unassisted younger eye.

In saying that an object appears larger at one time, or to one person, than another, it is necessary to guard against misconception. By the apparent size of an object we mean the angle it subtends at the eye, or the angle formed by two lines drawn from the centre of the eye to the extremities of the object. In *fig.* 1, the lines A E and B E drawn from the arrow to the eye form the angle A E B, which, when the angle is small, is nearly twice as great as the angle C E D formed by

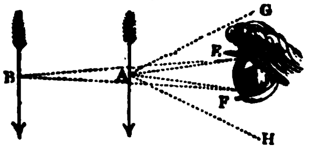
Fig. 1.



lines drawn from a similar arrow at twice the distance. The arrow AB will therefore appear nearly twice as long as CD, being seen under twice the angle, and in the same proportion for any greater or lesser difference in distance. The angle in question is called the angle of vision, or the visual angle.

The angle of vision must however not be confounded with the angle of the pencil of light by which an object is seen, and which is explained in *fig.* 2. Here we have drawn two arrows placed in relation to the eye as before, and from the centre of each have drawn lines exhibiting the quantity of light which each point will send into the eye at the respective distances.

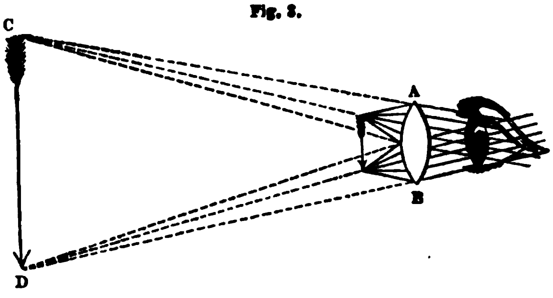
Fig. 2.



Now if EF represent the diameter of the pupil, the angle EAF shows the size of the cone or pencil of light which enters the eye from the point A, and in like manner the angle EBF is that of the pencil emanating from B, and entering the eye. Then, since EAF is double EBF, it is evident that A is seen by four times the quantity of light which could be received from an equally illuminated point at B; so that the nearer body would appear brighter if it did not appear larger; but as its apparent area is increased four times, as well as its light, no difference in this respect is discovered. But if we could find means to send into the eye a larger pencil of light, as for instance that shown by the lines GAH, without increasing the apparent size in the same proportion, it is evident that we should obtain a benefit totally distinct from that of increased magnitude, and one which is in some cases of even more importance than size in developing the structure of what we wish to examine. This, it will be hereafter shown, is sometimes done; for the present, we wish merely to explain clearly the distinction between apparent magnitude, or the angle under which the object is seen, and apparent brightness, or the angle of the pencil of light by which each of its points is seen, and with these explanations we shall continue to employ the common expressions magnifying glass and magnifying power.

The magnifying power of a single lens depends upon its focal length, the object being in fact placed nearly in its principal focus, or so that the light which diverges from each point may, after refraction by the lens, proceed in parallel lines to the eye, or as nearly so as is requisite for distinct vision. In *fig.* 3, AB is a double convex lens, near which is a small arrow to represent the object under examination, and the cones drawn from its extremities are portions of the rays of light diverging from those points and falling upon the lens. These rays, if suffered to fall at once upon the pupil, would be too divergent to permit their being brought to a focus upon the retina by the optical arrangements of the eye. But being first passed through the lens, they are bent into nearly parallel lines, or into lines diverging from some points within the limits of distinct vision, as from C and D. Thus altered, the eye receives them precisely as if they emanated from a larger arrow placed at CD, which we may suppose to be ten inches from the eye, and then the difference between the real and the imaginary arrow is called the magnifying power of the lens in question.

Fig. 3.



From what has been said it will be evident that two persons whose eyes differed as to the distance at which they obtained distinct vision, would give different results as to the magnifying power of a lens. To one who can see distinctly with the naked eye at a distance of five inches, the magnifying power would seem (and would indeed be) only half what we have assumed. Such instances are however rare; the focal length of the eye usually ranges from six to twelve or fourteen inches, so that the distance we first assumed of ten inches is very near the true average, and is a convenient number, inasmuch as a cipher added to the denominator of the fraction which expresses the focal length of a lens gives its magnifying power. Thus a lens whose focal length is one-sixteenth of an inch is said to magnify 160 times.

When the focal length of a lens is very small it is difficult to measure accurately the distance between its centre and its object. In such cases the best way to obtain the focal length for parallel or nearly parallel rays is to view the image of some distant object formed by the lens in question through another lens of one inch solar focal length, keeping both eyes open and comparing the image presented through the two lenses with that of the naked eye. The proportion between the two images so seen will be the focal length required. Thus if the image seen by the naked eye is ten times as large as that shown by the lenses, the focal length of the lens in question is one-tenth of an inch. The panes of glass in a window, or courses of bricks in a wall, are convenient objects for this purpose.

In whichever way the focal length of the lens is ascertained, the rules given for deducing its magnifying power are not rigorously correct, though they are sufficiently so for all practical purposes, particularly as the whole rests on an assumption in regard to the focal length of the eye, and as it does not in any way affect the actual measurement of the object. To calculate with great precision the magnifying power of a lens with a given focal length of eye, it is necessary that the thickness of the lens be taken into the account, and also the focal length of the eye itself.

We have hitherto considered a magnifying lens only in reference to its enlargement of the object, or the increase of the angle under which the object is seen. A further and equally important consideration is that of the number of rays or quantity of light by which every point of the object is rendered visible. The naked eye, as shown in *fig.* 2, admits from each point of every visible object a cone of light having the diameter of the pupil for its base, and most persons are familiar with that beautiful provision by which in cases of excessive brilliancy the pupil spontaneously contracts to reduce the cone of admitted light within bearable limits. This effect is still further produced in the experiment already described, of looking at an object through a needle-hole in a card, which is equivalent to reducing the pupil to the size of a needle-hole. Seen in this way the object becomes comparatively dark or obscure, because each point is seen by means of a very small cone of light, and a little consideration will suffice to explain the different effects produced by the needle-hole and the lens. Both change the angular value of the cone of light presented to the eye, but the lens changes the angle by bending the extreme rays within the limits suited to distinct vision, while the needle-hole effects the same purpose by cutting off the rays which exceed those limits.

It has been shown that removing a brilliant object to a greater distance will reduce the quantity of light which each point sends into the eye, as effectually as viewing it through a needle-hole; and magnifying an object by a lens has been shown to be the same thing in some respects as removing it to a greater distance. We have to see the magnified picture by the light emanating from the small object, and it becomes a matter of difficulty to obtain from each point a sufficient quantity of light to bear the diffusion of a great magnifying power. We want to perform an operation just the reverse of applying the card with the needle-hole to the eye—we want in some cases to bring into the eye the largest possible pencil of light from each point of the object.

Referring to *fig.* 3, it will be observed that if the eye could see the small arrow at the distance there shown without the intervention of the lens, only a very small portion of the cones of light drawn from its extremities would enter the pupil; whereas we have supposed that after being bent by the lens the whole of this light enters the eye as part of the cones of smaller angle whose summits are at C and D. These cones will further explain the difference between large and small pencils of light; those from the small arrow are large pencils; the dotted cones from the large arrow are small pencils.

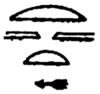
In assuming that the whole of this light could have been suffered to enter the eye through the lens AB, we did so for the sake of not perplexing the reader with too many considerations at once. He must now learn that so large a pencil of light passing through a single lens would be so distorted by the spherical figure of the lens, and by the chromatic dispersion of the glass, as to produce a very confused and imperfect image. This confusion may be greatly diminished by reducing the pencil; for instance, by applying a stop, as it is called, to the lens, which is neither more nor less than the needle-hole applied to the eye. A small pencil of light may be thus transmitted through a single lens without suffering from spherical aberration or chromatic dispersion any amount of distortion which will materially affect the figure of the object; but this quantity of light is insufficient to bear diffusion over the magnified picture, which is therefore too obscure to exhibit what we most desire to see—those beautiful and delicate markings by which one kind of organic matter is distinguished from another. With a small aperture these markings are not seen at all; with a large aperture and a single lens they exhibit a faint nebulous appearance enveloped in a chromatic mist, a state which is of course utterly valueless to the naturalist, and not even amusing to the amateur.

It becomes therefore a most important problem to reconcile a large aperture with distinctness, or, as it is called, *definition*; and this has been done in a considerable degree by effecting the required amount of refraction through two or more lenses instead of one, thus reducing the angles of incidence and refraction, and producing other effects which will be shortly noticed. This was first accomplished in a satisfactory manner by—

Dr. Wollaston's doublet,

invented by the celebrated philosopher whose name it bears; it consists of two plano-convex lenses (*fig.* 4) having their focal lengths in the proportion of 1 to 3, or nearly so, and placed at a distance which can be ascertained best by actual experiment. Their plane sides are placed towards the object, and the lens of shortest focal length next the object.

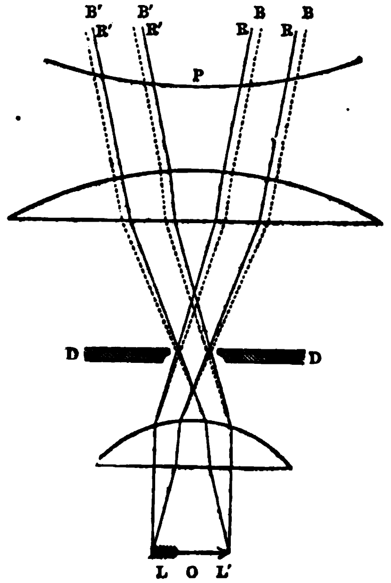
Fig. 4.



It appears that Dr. Wollaston was led to this invention by considering that the achromatic Huyghenean eye-piece, which will be hereafter described, would, if reversed, possess similar good properties as a simple microscope. But it will be evident when the eye-piece is understood, that the circumstances which render it achromatic are very imperfectly applicable to the simple microscope, and that the doublet, without a nice adjustment of the stop, would be valueless. Dr. Wollaston makes no allusion to a stop, nor is it certain that he contemplated its introduction, although his illness, which terminated fatally soon after the presentation of his paper, may account for the omission.

The nature of the corrections which take place in the doublet is explained in the annexed diagram (*fig.* 5), where L O L′ is the object, P a portion of the pupil, and D D the stop, or limiting aperture.

Fig. 5.

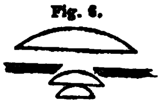


Now, it will be observed that each of the pencils of light from the extremities L L′ of the object is rendered excentrical by the stop, and of consequence each passes through the two lenses on opposite sides of their common axis O P; thus each becomes affected by opposite errors, which to some extent balance and correct each other. To take the pencil L, for instance, which enters the eye at R B R B, it is bent to the right at the first lens, and to the left at the second; and as each bending alters the direction of the blue rays more than the red, and moreover as the blue rays fall nearer the margin of the second lens, where the refraction, being more powerful than near the centre, compensates in some degree for the greater focal length of the second lens, the blue and red rays will emerge very nearly parallel, and of consequence colourless to the eye. At the same time the spherical aberration has been diminished by the circumstance that the side of the pencil which passes one lens nearest the axis passes the other nearest the margin.

This explanation applies only to the pencils near the extremities of the object. The central pencil, it is obvious, would pass both lenses symmetrically; the same portions of light occupying nearly the same relative places on both lenses. The blue light would enter the second lens nearer to its axis than the red, and being thus less refracted than the red by the second lens, a small amount of compensation would take place, quite different in principle and inferior in degree to that which is produced in the excentrical pencils. In the intermediate spaces the corrections are still more imperfect and uncertain; and this explains the cause of the aberrations which must of necessity exist even in the best-made doublet. It is, however, infinitely superior to a single lens, and will transmit a pencil of an angle of from 35° to 50° without any very sensible errors. It exhibits therefore many of the usual test-objects in a very beautiful manner.

The next step in the improvement of the simple microscope bears more analogy to the eye-piece. This improvement was made by Mr. Holland, and it consists (as shown in *fig.* 6) in substituting two lenses for the first in the doublet, and retaining the stop between them and the third. The first bending, being thus effected by two lenses instead of one, is accompanied by smaller aberrations, which are therefore more completely balanced or corrected at the second bending, in the opposite direction, by the third lens. This combination, though called a triplet, is essentially a doublet, in which the anterior lens is divided into two. For it must be recollected that the first pair of lenses merely accomplishes what might have been done, though with less precision, by one; but the two lenses of the doublet are opposed to each other; the second diminishing the magnifying power of the first. The first pair of lenses in the triplet concur in producing a certain amount of magnifying power, which is diminished in quantity and corrected as to aberration at the third lens by the change in relation to the position of the axis which takes place in the pencil between what is virtually the first and second lens. In this combination the errors are still further reduced by the close approximation to the object which causes the refractions to take place near the axis. Thus the transmission of a still larger angular pencil, namely 65°, is rendered compatible with distinctness, and a more intense image is presented to the eye.

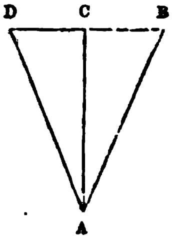
Fig. 6.



Every increase in the number of lenses is attended with one drawback, from the circumstance that a certain portion of light is lost by reflection and absorption each time that the ray enters a new medium. This loss bears no sensible proportion to the gain arising from the increased aperture, which, being as the square of the diameter, multiplies rapidly; or if we estimate by the angle of the admitted pencil, which is more easily ascertained, the intensity will be as the square of twice the tangent of half the angle.

To explain this, let D B (*fig.* 7) represent the diameter of the lens, or of that part of it which is really employed; C A the perpendicular drawn from its centre, and A B, A D, the extreme rays of the incident pencil of light D A B. Then the diameter being 2 C B, the area to which the intensity of vision is proportional will be $(2\ CB)^2$, and C B is evidently the tangent of the angle C A B, which is half the angle of the admitted pencil D A B. Or, if a be used to denote the angular aperture, the expression for the intensity is $(2 \tan. \frac{1}{2} a)^2$, which increases so rapidly with the increase of a, as to make the loss of light by reflection and absorption of little consequence.

Fig. 7.



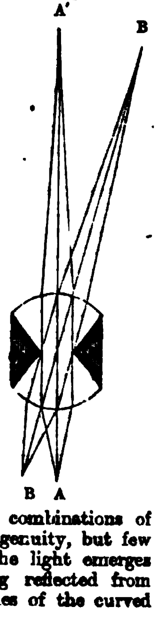
The combination of three lenses approaches, as has been stated, very close to the object; so close indeed as to prevent the use of more than three; and this constitutes a limit to the improvement of the simple microscope, (for it is called a simple microscope, although consisting of three lenses, and although a compound microscope may be made of only three or even two lenses;) but the different arrangement which gives rise to the term compound will be better understood when that instrument is explained.

Before we proceed to describe the simple microscope and its appendages, it will be well to explain such other points in reference to the form and materials of lenses as are most likely to be interesting.

A very useful form of lens was proposed by Dr. Wollaston, and called by him the periscopic lens. It consisted of two hemispherical lenses, cemented together by their plane faces, having a stop between them to limit the aperture. A similar proposal was made by Mr. Coddington, who, however, executed the project in a better manner, by cutting a groove in a whole sphere, and filling the groove with opaque matter. His lens, which is the well-known Coddington lens, is shown in *fig.* 8. It gives a large field of view, which is equally good in all directions, as it is evident that the pencils A A′ and B B′ pass through under precisely the same circumstances. Its spherical form has the further advantage of rendering the position in which it is held of comparatively little consequence. It is therefore very convenient as a hand-lens, but its definition is of course not so good as that of a well-made doublet or achromatic lens.

Another very useful form of doublet was proposed by Sir John Herschel, chiefly like the Coddington lens, for the sake of a wide field, and chiefly to be used in the hand. It is shown in *fig.* 9: it consists of a double convex or crossed lens, having the radii of curvature as 1 to 6, and of a plane concave lens whose focal length is to that of the convex lens as 13 to 5.

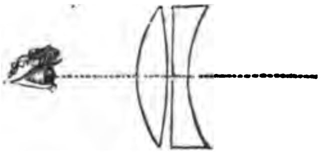
Fig. 8.



Various, indeed innumerable, other forms and combinations of lenses have been projected, some displaying much ingenuity, but few of any practical use. In the Catadioptric lenses the light emerges at right angles from its entering direction, being reflected from a surface cut at an angle of 45 degrees to the axes of the curved surfaces.

It was at one time hoped, as the precious stones are more refractive than glass, and as the increased refractive power is unaccompanied by a correspondent increase in chromatic dispersion, that they would furnish valuable materials for lenses, inasmuch as the refractions would be accomplished by shallower curves, and consequently with diminished spherical aberration. But these hopes were disappointed: everything that ingenuity and perseverance could accomplish was tried by Mr. Varley and Mr. Pritchard, under the patronage of Dr. Goring. It appeared, however, that the great reflective power, the doubly-refracting property, the colour, and the heterogeneous structure of the jewels which were tried, much more than counterbalanced the benefits arising from their greater refractive power, and left no doubt of the superiority of skilfully made glass doublets and triplets. The idea is now, in fact, abandoned; and the same remark is applicable to the attempts at constructing fluid lenses, and to the projects for giving to glass other than spherical surfaces.

Fig. 9.



By the term *simple* microscope is meant one in which the object is viewed directly through a lens or combination of lenses, just as we have supposed an arrow or an insect to be viewed through a glass held in the hand. When, however, the magnifying power of the glass is considerable, in other words, when its focal length is very short, and its proper distance from its object of consequence equally short, it requires to be placed at that proper distance with great precision: it cannot therefore be held with sufficient accuracy and steadiness by the unassisted hand, but must be mounted in a frame having a rack or screw to move it towards or from another frame or stage which holds the object. It is then called a microscope, and it is furnished, according to circumstances, with lenses and mirrors to collect and reflect the light upon the object, and with other conveniences which will now be described.

One of the best forms of a stand for a simple microscope is shown in *fig.* 10, where A is a brass pillar screwed to a tripod base; B is a broad stage for the objects, secured to the stem by screws, whose milled heads are at C. By means of the large milled head D, a triangular bar, having a rack, is elevated out of the stem A, carrying the lens-holder E, which has a horizontal movement in one direction, by means of a rack worked by the milled head F, and in the other direction by turning on a circular pin. A concave mirror G reflects the light upwards through the hole in the stage, and a lens may be attached to the stage for the purpose of throwing light on an opaque object, in the same way that the forceps H for holding such objects is attached. This microscope is peculiarly adapted, by its broad stage and its general steadiness, for dissecting; and it is rendered more convenient for this purpose by placing it between two inclined planes of mahogany, which support the arms and elevate the wrists to the level of the stage. This apparatus is called the dissecting rest. When dissecting is not a primary object, a joint may be made at the lower end of the stem A, to allow the whole to take an inclined position; and then the spring clips shown upon the stage are useful to retain the object in its place. Numerous convenient appendages may be made to accompany such microscopes, which it will be impossible to mention in detail: the most useful are Mr. Varley's capillary cages for containing animalculæ in water, and parts of aquatic plants; also his tubes for obtaining and separating such objects, and his phial and phial-holder for preserving and exhibiting small living specimens of the Chara, Nitella, and other similar plants, and observing their circulation. The phial-microscope affords facilities for observing the operations of minute vegetable and animal life.

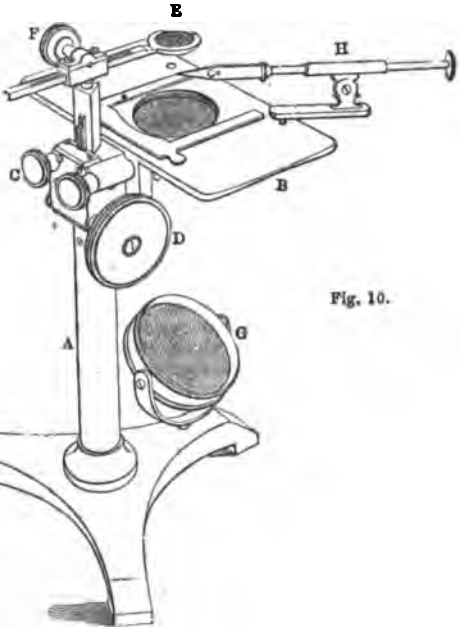
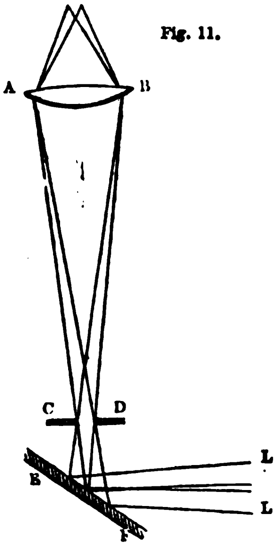


Fig. 10.

The mode of illuminating objects is one on which we must give some further information, for the manner in which an object is lighted is second in importance only to the excellence of the glass through which it is seen. In investigating any new or unknown specimen, it should be viewed in turns by every description of light, direct and oblique, as a transparent object and as an opaque object, with strong and with faint light, with large angular pencils and with small angular pencils thrown in all possible directions. Every change will probably develope some new fact in reference to the structure of the object, which should itself be varied in the mode of mounting in every possible way. It should be seen both wet and dry, and immersed in fluids of various qualities and densities, such, for instance, as water, alcohol, oil, and Canada balsam, which last has a refractive power nearly equal to that of glass. If the object be delicate vegetable tissue, it will be in some respects rendered more visible by gentle heating or scorching by a clear fire placed between two plates of glass. In this way the spiral vessels of asparagus and other similar vegetables may be beautifully displayed. Dyeing the objects in tincture of iodine will in some cases answer this purpose better.

But the principal question in regard to illumination is the magnitude of the illuminating pencil, particularly in reference to transparent objects. Generally speaking the illuminating pencil should be as large as can be received by the lens, and no larger. Any light beyond this produces indistinctness and glare. The superfluous light from the mirror may be cut off by a screen having various-sized apertures placed below the stage; but the best mode of illumination is that proposed by Dr. Wollaston, and called the Wollaston condenser. A tube is placed below the stage of the instrument containing a lens A B (*fig.* 11), which can be elevated or depressed within certain limits at pleasure; and at the lower end is a stop with a limited aperture C D. A plane mirror E F receives the rays of light L L from the sky or a white cloud, which last is the best source of light, and reflects them upwards through the aperture in C D, so that they are refracted, and form an image of the aperture at G, which is supposed to be nearly the place of the object. The object is sometimes best seen when the image of the aperture is also best seen; and sometimes it is best to elevate the summit G of the cone A B G above the object, and at others to depress it below: all which is done at pleasure by the power of moving the lens A B. If artificial light (as a lamp or candle) be employed, the flame must be placed in the principal focus of a large detached lens on a stand, so that the rays L L may fall in parallel lines on the mirror, or as they would fall from the cloud. This will be found an advantage, not only when the Wollaston condenser is employed, but also when the mirror and diaphragm are used. A good mode of imitating artificially the light of a white cloud opposite the sun has been proposed by Mr. Varley: he covers the surface of the mirror under the stage with carbonate of soda or any similar material,

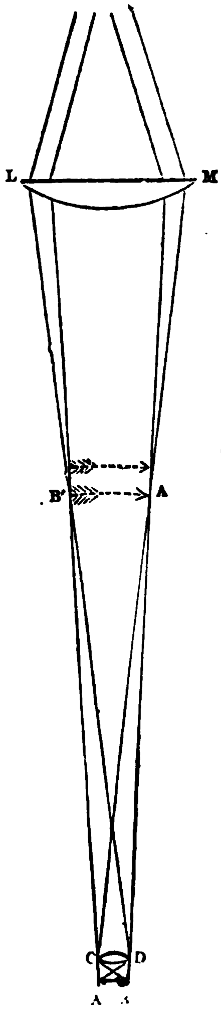
Fig. 11.



and then concentrates the sun's light upon its surface by a large condensing lens. The intense white light diffused from the surface of the soda forms an excellent substitute for the white cloud, which, when opposite the sun and of considerable size, is the best day-light, as the pure sky opposite to the sun is the worst.

The Compound Microscope may, as before stated, consist of only two lenses, while a simple microscope has been shown to contain sometimes three. In the triplet for the simple microscope, however, it was explained that the effect of the two first lenses was to do what might have been accomplished, though not so well, by one; and the third merely effected certain modifications in the light before it entered the eye. But in the compound microscope the two lenses have totally different functions; the first receives the rays from the object, and, bringing them to new foci, forms an image, which the second lens treats as an original object, and magnifies it just as the single microscope magnified the object itself.

Fig. 12.



The annexed figure (12) shows the course of the rays through a compound microscope of two lenses The rays proceeding from the object A B are so acted upon by the lens C D. near it, and thence called the objective, that they are converged to foci in A'B', where they form an enlarged image of the object, as would be evident if a piece of oiled paper or ground glass were placed there to receive them. They are not so intercepted, and therefore the image is not rendered visible at that place; but their further progress is similar to what it would have been had they really proceeded from an object at A'B. They are at length received by the eye-lens L M, which acts upon them as the simple microscope has been described to act on the light proceeding from its objects. They are bent so that they may enter the eye at E in parallel lines, or as nearly so as is requisite for distinct vision. When we say that the rays enter the eye in nearly parallel lines, we mean only those which proceed from one point of the original object. Thus the two parallel rays M E have proceeded from and are part of the cone of rays C A D, emanating from the point A of the arrow; but they do not form two pictures in the eye, because any number of parallel rays which the pupil can receive will be converged to a point by the eye, and will convey the impression of one point to the mind. In like manner the rays L E are part of the cone of rays emanating from B, and the angle L E M is that under which the eye will see the magnified image of the arrow, which is evidently many times greater than the arrow could be made to occupy in the naked eye at any distance within the limits of distinct vision. The magnifying power depends on two circumstances: first, on the ratio between the anterior distance A C or B D and the posterior focal length C B or D A'; and secondly, on the power of the eye-lens L M. The first ratio is the same as that between the object A B and the image A'B'; this and the focal length or power of the eye-lens are both easily obtained, and their product is the power of the compound instrument.

Since the power depends on the ratio between the anterior and posterior foci of the objective, it is evident that by increasing that ratio any power may be obtained, the same eye-glass being used; or, having determined the first, any further power may be obtained by increasing that of the eye-glass; and thus, by a pre-arrangement of the relative proportions in which the magnifying power shall be divided between the objective and the eye-glass, almost any given distance (within certain limits) between the first and its object may be secured. This is one valuable peculiarity of the compound instrument; and another is the large field, or large angle of view, which may be obtained, every part of which will be nearly equally good; whereas with the best simple microscopes the field is small, and is good only in the centre. The field of the compound instrument is further increased by using two glasses at the eye-end; the first being called, from its purpose, the field-glass, and the two constituting what is called the eye-piece. This will be more particularly explained in the figure of the achromatic compound microscope presently given.

For upwards of a century the compound microscope, notwithstanding the advantages above mentioned, was a comparatively feeble and inefficient instrument, owing to the distance which the light had to traverse, and the consequent increase of the chromatic and spherical aberrations. To explain this we have drawn in *fig.* 12 a second image near A'B', the fact being that the object-glass would not form one image, as has been supposed, but an infinite number of variously-coloured and various-sized images, occupying the space between the two dotted arrows. Those nearest the object-glass would be red, and those nearest the eye-glass would be blue. The effect of this is to produce so much confusion, that the instrument was reduced to a mere toy, although these errors were diminished to the utmost possible extent by limiting the aperture of the object-glass, and thus restricting the angle of the pencil of light from each point of the object. But this involved the defects, already explained, of making the picture obscure, so that on the whole the best compound instruments were inferior to the simple microscopes of a single lens, with which indeed all the important observations of the last century were made.

Even after the improvement of the simple microscope by the use of doublets and triplets, the long course of the rays and the large angular pencil required in the compound instrument deterred the most sanguine from anticipating the period when they should be conducted through such a path free both from spherical and chromatic errors. Philosophers of no less eminence than M. Biot and Dr. Wollaston had predicted that the compound would never rival the simple microscope, and that the idea of achromatising its object-glass was hopeless. Nor can these opinions be wondered at when we consider how many years the achromatic telescope had existed without an attempt to apply its principles to the compound microscope. When we consider the smallness of the pencil required by the telescope, and the enormous increase of difficulty attending every enlargement of the pencil—when we consider further that these difficulties had to be contended with and removed by operations on portions of glass so small that they are themselves almost microscopic objects, we shall not be surprised that even a cautious philosopher and most able manipulator like Dr. Wollaston should prescribe limits to improvement.

Fortunately for science, and especially for the departments of animal and vegetable physiology, these predictions have been shown to be unfounded. The compound microscope has been elevated from the condition we have described to that of being the most important instrument ever bestowed by art upon the investigator of nature. It now holds a very high rank among philosophical implements, while the transcendent beauties of form, colour, and organisation which it reveals to us in the minute works of nature, render it subservient to the most delightful and instructive pursuits. To these claims on our attention it appears likely to add a third of still higher importance. The microscopic examination of the blood and other human organic matter will in all probability afford more satisfactory and conclusive evidence regarding the nature and seat of disease than any hitherto appealed to, and will of consequence lead to similar certainty in the choice and application of remedies.

Soon after the year 1820 a series of experiments was begun in France by M. Selligues, which were followed up by Frauenhofer at Münich, by Amici at Modena, by M. Chevalier at Paris, and by the late Mr. Tulley in London. In 1824 the last-named excellent artist, without knowing what had been done on the Continent, made the attempt to construct an achromatic objective for a compound microscope, and produced one of nine-tenths of an inch focal length, composed of three lenses, and transmitting a pencil of eighteen degrees. This was the first that had been made in England; and it is due to Mr. Tulley to say, that as regards accurate correction throughout the field, that glass has not been excelled by any subsequent combination of three lenses. Such an angular pencil, and such a focal length, would bear an eye-piece adapted to produce a gross magnifying power of one hundred and twenty. Mr. Tulley afterwards made a combination to be placed in front of the first-mentioned, which increased the angle of the transmitted pencil to thirty-eight degrees, and bore a power of three hundred.

While these practical investigations were in progress, the subject of achromatism engaged the attention of some of the most profound mathematicians in England. Sir John Herschel, Professor Airy, Professor Barlow, Mr. Coddington, and others, contributed largely to the theoretical examination of the subject; and though the results of their labours were not immediately applicable to the microscope, they essentially promoted its improvement.

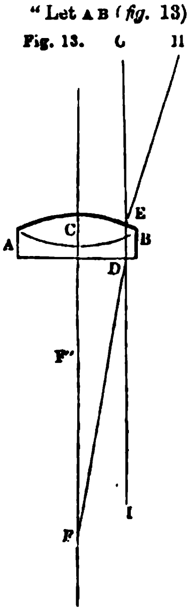
For some time prior to 1829 the subject had occupied the mind of a gentleman, who, not entirely practical, like the first, nor purely mathematical, like the last-mentioned class of inquirers, was led to the discovery of certain properties in achromatic combinations which had been before unobserved. These were afterwards experimentally verified; and in the year 1829 a paper on the subject, by the discoverer, Mr. Joseph Jackson Lister, was read and published by the Royal Society. The principles and results thus obtained enabled Mr. Lister to form a combination of lenses which transmitted a pencil of fifty degrees, with a large field correct in every part: as this paper was the foundation of the recent improvements in achromatic microscopes, and as its results are indispensable to all who would make or understand the instrument, we shall give the more important parts of it in detail, and in Mr. Lister's own words.

"I would premise that the plano-concave form for the correcting flint lens has in that quality a strong recommendation, particularly as it obviates the danger of error which otherwise exists in centring the two curves, and thereby admits of correct workmanship for a shorter focus. To cement together also the two surfaces of the glass diminishes by very nearly half the loss of light from reflexion, which is considerable at the numerous surfaces of a combination. I have thought the clearness of the field and brightness of the picture evidently increased by doing this; it prevents any dewiness or vegetation from forming on the inner surfaces; and I see no disadvantage to be anticipated from it if they are of identical curves, and pressed closely together, and the cementing medium permanently homogeneous.

"These two conditions then, that the flint lens shall be plano-concave, and that it shall be joined by some cement to the convex, seem desirable to be taken as a basis for the microscopic object-glass, provided they can be reconciled with the destruction of the spherical and chromatic aberrations of a large pencil.

"Now in every such glass that has been tried by me which has had its correcting lens of either Swiss or English glass, with a double convex of plate, and has been made achromatic by the form given to the outer curve of the convex, the proportion has been such between the refractive and dispersive powers of its lenses, that its figure has been correct for rays issuing from some point in its axis not far from its principal focus on its plane side, and either tending to a conjugate focus within the tube of a microscope, or emerging nearly parallel.

Fig. 13.



"Let AB (*fig.* 13) be supposed such an object-glass, and let it be roughly considered as a plano-convex lens, with a curve ABC running through it, at which the spherical and chromatic errors are corrected which are generated at the two outer surfaces; and let the glass be thus free from aberration for rays FDEG issuing from the radiant point F, HE being a perpendicular to the convex surface, and ID to the plane one. Under these circumstances, the angle of emergence GEH much exceeds that of incidence FDI, being probably nearly three times as great.

"If the radiant is now made to approach the glass, so that the course of the ray FDEG shall be more divergent from the axis, as the angles of incidence and emergence become more nearly equal to each other, the spherical aberration produced by the two will be found to bear a less proportion to the opposing error of the single correcting curve ACB; for such a focus therefore the rays will be over-corrected.

"But if F still approaches the glass, the angle of incidence continues to increase with the increasing divergence of the ray, till it will exceed that of emergence, which has in the meanwhile been diminishing, and at length the spherical error produced by them will recover its original proportion to the opposite error of the curve of correction. When F has reached this point F″ (at which the angle of incidence does not exceed that of emergence so much as it had at first come short of it), the rays again pass the glass free from spherical aberration.

"If F be carried from hence towards the glass, or outwards from its original place, the angle of incidence in the former case, or of emergence in the latter, becomes disproportionately effective, and either way the aberration exceeds the correction.

"These facts have been established by careful experiment: they accord with every appearance in such combinations of the plano-convex glasses as have come under my notice, and may, I believe, be extended to this rule, that in general an achromatic object-glass, of which the inner surfaces are in contact, or nearly so, will have on one side of it two foci in its axis, for the rays proceeding from which it will be truly corrected at a moderate aperture; that for the space between these two points its spherical aberration will be over-corrected, and beyond them either way under-corrected.

"The longer aplanatic focus may be found, when one of the plano-convex object-glasses is placed in a microscope, by shortening the tube, if the glass shows over-correction; if under-correction, by lengthening it, or by bringing the rays together, should they be parallel or divergent, by a very small good telescope. The shorter focus is got at by sliding the glass before another of sufficient length and large aperture that is finely corrected, and bringing it forwards till it gives the reflexion of a bright point from a globule of quicksilver, sharp and free from mist, when the distance can be taken between the glass and the object.

"The longer focus is the place at which to ascertain the utmost aperture that may be given to the glass, and where, in the absence of spherical error, its exact state of correction as to colour is seen most distinctly.

"The correction of the chromatic aberration, like that of the spherical, tends to excess in the marginal rays; so that if a glass which is achromatic, with a moderate aperture, has its cell opened wider, the circle of rays thus added to the pencil will be rather over-corrected as to colour.

"The same tendency to over-correction is produced, if, without varying the aperture, the divergence of the incident rays is much augmented, as in an object-glass placed in front of another; but generally in this position a part only of its aperture comes into use; so that the two properties mentioned neutralise each other, and its chromatic state remains unaltered. If for example the outstanding colours were observed at the longer focus to be green and claret, which show that the nearest practicable approach is made to the union of the spectrum, they usually continue nearly the same for the whole space between the foci, and for some distance beyond them either way.

"The places of these two foci and their proportions to each other depend on a variety of circumstances. In several object-glasses that I have had made for trial, plano-convex, with their inner surfaces cemented, their diameters the radius of the flint lens, and their colour pretty well corrected, those composed of dense flint and light plate have had the rays from the longer focus emerging nearly parallel; and this focus has been not quite three times the distance of the shorter from the glass: with English flint the rays have had more convergence, and the shorter focus has borne a rather less proportion to the longer.

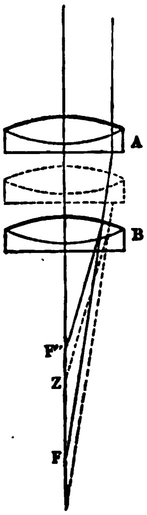
"If the surfaces are not cemented, a striking effect is produced by minute differences in their curves. It may give some idea of this, that in a glass of which nearly the whole disc was covered with colour from contact of the lenses, the addition of a film of varnish, so thin that this colour was not destroyed by it, caused a sensible change in the spherical correction.

"I have found that whatever extended the longer aplanatic focus, and increased the convergence of its rays, diminished the relative length of the shorter. Thus by turning to the concave lens the flatter instead of the deeper side of a convex lens, whose radii were to each other as 31 to 35, the pencil of the longer aplanatic focus, from being greatly divergent, was brought to converge at a very small distance behind the glass; and the length of the shorter focus, which had been one-half that of the longer, became but one-sixth of it.

"The direction of the aplanatic pencils appears to be scarcely affected by the differences in the thickness of glasses, if their state as to colour is the same.

"One other property of the double object-glass remains to be mentioned, which is, that when the longer aplanatic focus is used, the marginal rays of a pencil not coincident with the axis of the glass are distorted, so that a coma is thrown outwards; while the contrary effect of a coma directed towards the centre of the field is produced by the rays from the shorter focus. These peculiarities of the coma seem inseparable attendants on the two foci, and are as conspicuous in the achromatic meniscus as in the plano-convex object-glass.

Fig. 14.



"Of several purposes to which the particulars just given seem applicable, I must at present confine myself to the most obvious one. They furnish the means of destroying with the utmost ease both aberrations in a large focal pencil, and of thus surmounting what has hitherto been the chief obstacle to the perfection of the microscope. And when it is considered that the curves of its diminutive object-glasses have required to be at least as exactly proportioned as those of a large telescope to give the image of a bright point equally sharp and colourless, and that any change made to correct one aberration was liable to disturb the other, some idea may be formed of what the amount of that obstacle must have been. It will however be evident that if any object-glass is but made achromatic, with its lenses truly worked and cemented, so that their axes coincide, it may with certainty be connected with another possessing the same requisites and of suitable focus, so that the combination shall be free from spherical error also in the centre of its field. For this the rays have only to be received by the front glass B (*fig.* 14) from its shorter aplanatic focus F″, and transmitted in the direction of the longer correct pencil FA of the other glass A. It is desirable that the latter pencil should neither converge to a very short focus nor be more than very slightly if at all divergent; and a little attention at first to the kind of glass used will keep it within this range, the denser flint being suited to the glasses of shorter focus and larger angle of aperture.

"The adjustment of the microscope is then perfected, if necessary, by slightly varying the distance between the object-glasses; and after that is done, the length of the tube which carries the eye-pieces may be altered greatly without disturbing the correction, opposite errors which balance each other being produced by the change.

"If the two glasses which in the diagram are drawn at some distance apart are brought nearer together (if the place of A for instance is carried to the dotted figure), the rays transmitted by B in the direction of the longer aplanatic pencil of A will plainly be derived from some point Z more distant than F″, and lying between the aplanatic foci of B; therefore (according to what has been stated) this glass, and consequently the combination, will then be spherically over-corrected. If on the other hand the distance between A and B is increased, the opposite effects are of course produced.

"In combining several glasses together it is often convenient to transmit an under-corrected pencil from the front glass, and to counteract its error by over-correction in the middle one.

"Slight errors in colour may in the same manner be destroyed by opposite ones; and on the principles described we not only acquire fine correction for the central ray, but, by the opposite effects at the two foci on the transverse pencil, all coma can be destroyed, and the whole field rendered beautifully flat and distinct."

Mr. Lister's paper enters into further particulars, which are not essential to the comprehension of the subject. It is sufficient to say that his investigations and results proved to be of the highest value to the practical optician, and the progress of improvement was in consequence extremely rapid. The new principles were applied and exhibited by Mr. Hugh Powell and Mr. Andrew Ross with a degree of success which had never been anticipated; so perfect indeed were the corrections given to the achromatic object-glass—so completely were the errors of sphericity and dispersion balanced or destroyed—that the circumstance of covering the object with a plate of the thinnest glass or talc disturbed the corrections, if they had been adapted to an uncovered object, and rendered an object-glass which was perfect under one condition sensibly defective under the other.

This defect, if that should be called a defect which arose out of improvement, was first discovered by Mr. Ross, who immediately suggested the means of correcting it, and presented to the Society of Arts, in 1837, a paper on the subject, which was published in the 51st volume of their Transactions, and which, as it is, like Mr. Lister's, essential to a full understanding of the ultimate refinements of the instrument, we shall extract nearly in full.

"In the course of a practical investigation (says Mr. Ross) with the view of constructing a combination of lenses for the object-glass of a compound microscope, which should be free from the effects of aberration, both for central and oblique pencils of great angle, I combined the condition of the greatest possible distance between the object and object-glass; for in object-glasses of short focal length their closeness to the object has been an obstacle in many cases to the use of high magnifying powers, and is a constant source of inconvenience.

"In the improved combination, the diameter is only sufficient to admit the proper pencil; the convex lenses are wrought to an edge, and the concave have only sufficient thickness to support their figure; consequently, the combination is the thinnest possible, and it follows that there will be the greatest distance between the object and the object-glass. The focal length is $\frac{1}{8}$ of an inch, having an angular aperture of 60°, with a distance of $\frac{1}{25}$ of an inch, and a magnifying power of 970 times linear with perfect definition on the most difficult Podura scales. I have made object-glasses $\frac{1}{15}$ of an inch focal length; but as the angular aperture cannot be advantageously increased, if the greatest distance between the object and object-glass is preserved, their use will be very limited.

"The quality of the definition produced by an achromatic compound microscope will depend upon the accuracy with which the aberrations, both chromatic and spherical, are balanced, together with the general perfection of the workmanship. Now, in Wollaston's doublets, and Holland's triplets, there are no means of producing a balance of the aberrations, as they are composed of convex lenses only; therefore the best that can be done is to make the aberrations a minimum: the remaining positive aberration in these forms produces its peculiar effect upon objects (particularly the detail of the thin transparent class), which may lead to misapprehension of their true structure; but with the achromatic object-glass, where the aberrations are correctly balanced, the most minute parts of an object are accurately displayed, so that a satisfactory judgment of their character may be formed.

Fig. 15.

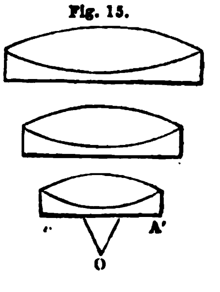
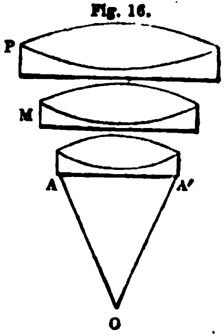


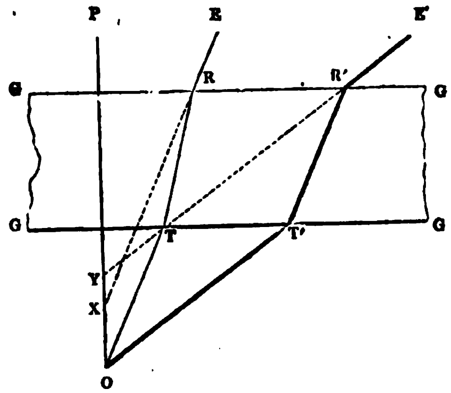
Fig. 16.



"It will be seen by *fig.* 15, that when a certain angular pencil A O A' proceeds from the object O, and is incident on the plane side of the first lens, if the combination is removed from the object, as in *fig.* 16, the extreme rays of the pencil impinge on the more marginal parts of the glass, and as the refractions are greater here, the aberrations will be greater also. Now, if two compound object-glasses have their aberrations balanced, one being situated as in *fig.* 15, and the other as in *fig.* 16, and the same disturbing power applied to both, that in which the angles of incidence and the aberrations are small will not be so much disturbed as where the angles are great, and where consequently the aberrations increase rapidly.

"When an object-glass has its aberrations balanced for viewing an opaque object, and it is required to examine that object by transmitted light, the correction will remain; but if it is necessary to immerse the object in a fluid, or to cover it with glass or talc, an aberration will arise from these circumstances, which will disturb the previous correction, and consequently deteriorate the definition; and this effect will be more obvious with the increase of the distance between the object and the object-glass.

Fig. 17.

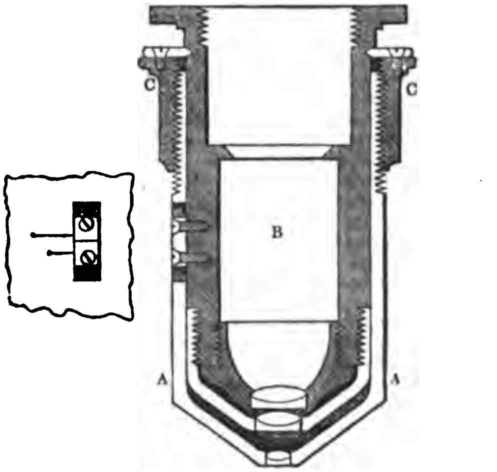


"The aberration produced with diverging rays by a piece of flat and parallel glass, such as would be used for covering an object, is represented at *fig.* 17, where G G G G is the refracting medium, or piece of glass covering the object O; O P, the axis of the pencil, perpendicular to the flat surfaces; O T, a ray near the axis; and O T', the extreme ray of the pencil incident on the under surface of the glass: then T R, T' R', will be the directions of the rays in the medium, and R E, R' E', those of the emergent rays. Now if the course of these rays is continued, as by the dotted lines, they will be found to intersect the axis at different distances, X and Y, from the surface of the glass; and the distance X Y is the aberration produced by the medium which, as before stated, interferes with the previously balanced aberrations of the several lenses composing the object-glass. There are many cases of this, but the one here selected serves best to illustrate the principle. I need not encumber the description with the theoretical determination of this quantity, as it varies with exceedingly minute circumstances which we cannot accurately control; such as the distance of the object from the under side of the glass, and the slightest difference in the thickness of the glass itself; and if these data could be readily obtained, the knowledge would be of no utility in making the correction, that being wholly of a practical nature.

"If an object-glass is constructed as represented in *fig.* 16, where the posterior combination P and the middle M have together an excess of negative aberration, and if this be corrected by the anterior combination A, having an excess of positive aberration, then this latter combination can be made to act more or less powerfully upon P and M, by making it approach to or recede from them; for when the three are in close contact, the distance of the object from the object-glass is greatest; and consequently the rays from the object are diverging from a point at a greater distance than when the combinations are separated; and as a lens bends the rays more, or acts with greater effect, the more distant the object is from which the rays diverge, the effect of the anterior combination A upon the other two, P and M, will vary with its distance from thence. When, therefore, the correction of the whole is effected for an opaque object with a certain distance between the anterior and middle combination, if they are then put in contact, the distance between the object and object-glass will be increased: consequently the anterior combination will act more powerfully, and the whole will have an excess of positive aberration. Now the effect of the aberration produced by a piece of flat and parallel glass being of the negative character, it is obvious that the above considerations suggest the means of correction by moving the lenses nearer together, till the positive aberration thereby produced balances the negative aberration caused by the medium.

"The preceding refers only to the spherical aberration, but the effect of the chromatic is also seen when an object is covered with a piece of glass; for, in the course of my experiments, I observed that it produced a chromatic thickening of the outlines of the Podura and other delicate scales; and if diverging rays near the axis and at the margin are projected through a piece of flat parallel glass, with the various indices of refraction for the different colours, it will be seen that each ray will emerge separated into a beam consisting of the component colours of the ray, and that each beam is widely different in form. This difference, being magnified by the power of the microscope, readily accounts for the chromatic thickening of the outline just mentioned. Therefore, to obtain the finest definition of extremely delicate and minute objects, they should be viewed without a covering; if it be desirable to immerse them in a fluid, they should be covered with the thinnest possible film of talc, as, from the character of the chromatic aberration, it will be seen that varying the distances of the combinations will not sensibly affect the correction; though object-lenses may be made to include a given fluid or solid medium in their correction for colour.

Fig. 18.

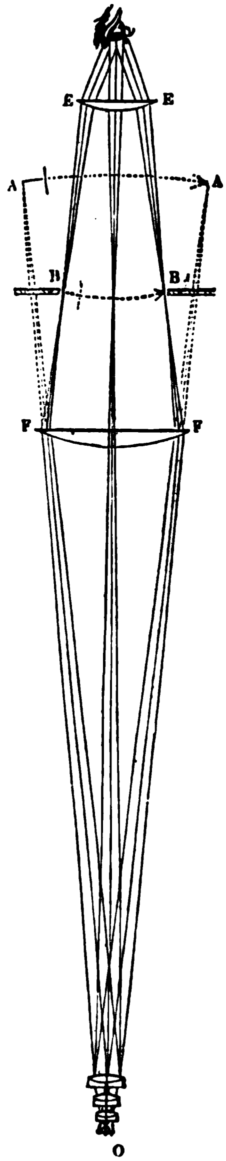


"The mechanism for applying these principles to the correction of an object-glass under the various circumstances is represented in *fig.* 18, where the anterior lens is set in the end of a tube A A, which slides on the cylinder B containing the remainder of the combination; the tube A A, holding the lens nearest the object, may then be moved upon the cylinder B, for the purpose of varying the distance according to the thickness of the glass covering the object, by turning the screwed ring C C, or more simply by sliding the one on the other, and clamping them together when adjusted. An aperture is made in the tube A, within which is seen a mark engraved on the cylinder, and on the edge of which are two marks, a longer and a shorter, engraved upon the tube. When the mark on the cylinder coincides with the longer mark on the tube, the adjustment is perfect for an uncovered object; and when the coincidence is with the short mark, the proper distance is obtained to balance the aberrations produced by glass $\frac{1}{100}$th of an inch thick, and such glass can be readily supplied.

"It is hardly necessary to observe, that the necessity for this correction is wholly independent of any particular construction of the object-glass; as in all cases where the object-glass is corrected for an object uncovered, any covering of glass will create a different value of aberration to the first lens, which previously balanced the aberration resulting from the rest of the lenses; and as this disturbance is effected at the first refraction, it is independent of the other part of the combination. The visibility of the effect depends on the distance of the object from the object-glass, the angle of the pencil transmitted, the focal length of the combination, the thickness of the glass covering the object, and the general perfection of the corrections for chromatism and the oblique pencils.

"With this adjusting object-glass, therefore, we can have the requisites of the greatest possible distance between the object and object-glass, an intense and sharply defined image throughout the field from the large pencil transmitted, and the accurate correction of the aberrations; also, by the adjustment, the means of preserving that correction under all the varied circumstances in which it may be necessary to place an object for the purpose of observation."

Fig. 19.

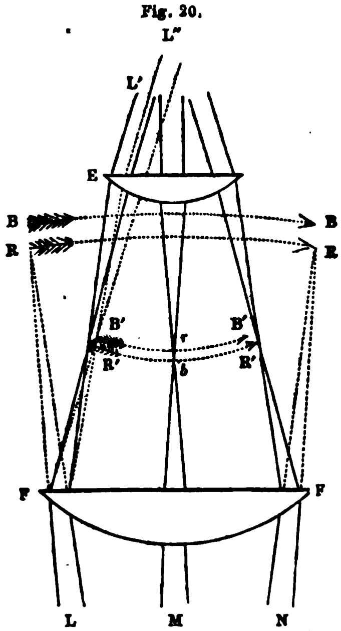


In the annexed engraving, *fig.* 19, we have shown the triple achromatic objective in connection with the eye-piece consisting of the field-glass F F and the eye-glass E E, forming together the modern achromatic telescope. The course of the light is shown by drawing three rays from the centre and three from each end of the object O. These rays would, if left to themselves, form an image of the object at A A, but being bent and converged by the field-glass F F, they form the image at B B, where a stop is placed to intercept all light except what is required for the formation of the image. From B B, therefore, the rays proceed to the eye-glass exactly as has been described in reference to the simple microscope and to the compound of two glasses.

If we stopped here we should convey a very imperfect idea of the beautiful series of corrections effected by the eye-piece, and which were first pointed out in detail in a paper on the subject published by Mr. Varley in the 51st volume of the 'Transactions of the Society of Arts.' The eye-piece in question was invented by Huyghens for telescopes, with no other view than that of diminishing the spherical aberration by producing the refractions at two glasses instead of one, and of increasing the field of view. It was reserved for Boscovich to point out that Huyghens had by this arrangement accidentally corrected a great part of the chromatic aberration; and this subject is further investigated with much skill in two papers by Professor Airy in the 'Cambridge Philosophical Transactions,' to which we refer the mathematical reader. These investigations apply chiefly to the telescope, where the small pencils of light and great distance of the object exclude considerations which become important in the microscope, and which are well pointed out in Mr. Varley's paper before mentioned.

Let *fig.* 20 represent the Huyghenean eye-piece of a microscope; F F and E E being the field-glass and eye-glass, and L M N the two extreme rays of each of the three pencils, emanating from the centre and ends of the object, of which, but for the field-glass, a series of coloured images would be formed from R R to B B; those near R R being red, those near B B blue, and the intermediate ones green, yellow, and so on, corresponding with the colours of the prismatic spectrum. This order of colours, it will be observed, is the reverse of that described in treating of the common compound microscope (*fig.* 12), in which the single object-glass projected the red image beyond the blue. The effect just described, of projecting the blue image beyond the red, is purposely produced for reasons presently to be given, and is called over-correcting the object-glass as to colour. It is to be observed, also, that the images B B and R R are curved in the wrong direction to be distinctly seen by a convex eye-lens, and this is a further defect of the compound microscope of two lenses. But the field-glass, at the same time that it bends the rays and converges them to foci at B′ B′ and R′ R′, also reverses the curvature of the images as there shown, and gives them the form best adapted for distinct vision by the eye-glass E E. The field-glass has at the same time brought the blue and red images closer together, so that they are adapted to pass uncoloured through the eye-glass. To render this important point more intelligible, let it be supposed that the objective had not been over-corrected, that it had been perfectly achromatic; the rays would then have become coloured as soon as they had passed the field-glass; the blue rays, to take the central pencil for example, would converge at *b* and the red rays at *r*, which is just the reverse of what the eye-lens requires; for as its blue focus is also shorter than its red, it would demand rather that the blue image should be at *r* and the red at *b*. This effect we have shown to be produced by the over-correction of the objective, which protrudes

Fig. 20.



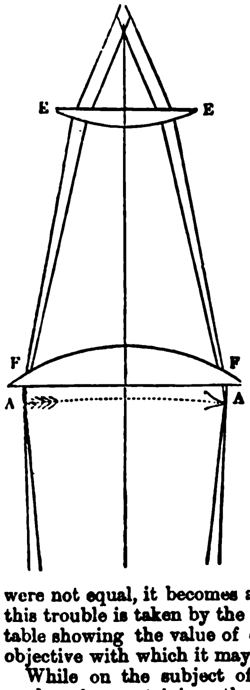
the blue foci B B as much beyond the red foci R R as the sum of the distances between the red and blue foci of the field-lens and eye-lens; so that the separation B R is exactly taken up in passing through those two lenses, and the whole of the colours coincide as to focal distance as soon as the rays have passed the eye-lens. But while they coincide as to distance, they differ in another respect; the blue images are rendered smaller than the red by the superior refractive power of the field-glass upon the blue rays. In tracing the pencil L, for instance, it will be noticed that after passing the field-glass two sets of lines are drawn, one whole and one dotted, the former representing the red, and the latter the blue rays. This is the accidental effect in the Huyghenean eye-piece pointed out by Boscovich. This separation into colours at the field-glass is like the over-correction of the objective; it leads to a subsequent complete correction. For if the differently coloured rays were kept together till they reached the eye-glass, they would then become coloured, and present coloured images to the eye; but fortunately, and most beautifully, the separation effected by the field-glass causes the blue rays to fall so much nearer the centre of the eye-glass, where, owing to the spherical figure, the refractive power is less than at the margin, that the spherical error of the eye-lens constitutes a nearly perfect balance to the chromatic dispersion of the field-lens, and the red and blue rays L′ and L″ emerge sensibly parallel, presenting, in consequence, the perfect definition of a single point to the eye. The same reasoning is true of the intermediate colours and of the other pencils.

From what has been stated, it is obvious that we mean by an achromatic objective one in which the usual order of dispersion is so far reversed, that the light, after undergoing the singularly beautiful series of changes effected by the eye-piece, shall come uncoloured to the eye. We can give no specific rules for producing these results. Close study of the formulæ for achromatism given by the celebrated mathematicians we have quoted will do much, but the principles must be brought to the test of repeated experiment. Nor will the experiments be worth anything unless the curves be most accurately measured and worked, and the lenses centred and adjusted with a degree of precision which, to those who are familiar only with telescopes, will be quite unprecedented.

The Huyghenean eye-piece which we have described is the best for merely optical purposes; but when it is required to measure the magnified image, we use the eye-piece invented by Mr. Ramsden, and called, from its purpose, the micrometer eye-piece. When it is stated that we sometimes require to measure portions of animal or vegetable matter a hundred times smaller than any divisions than can be artificially made on any measuring instrument, the advantage of applying the scale to the magnified image will be obvious, as compared with the application of engraved or mechanical micrometers to the stage of the instrument.

The arrangement is shown in *fig.* 21, where E E and F F are the eye- and field-glass, the latter having now its plane face towards the object. The rays from the object are here made to converge at A A, immediately in front of the field-glass, and here also is placed a plane glass on which are engraved divisions of $\frac{1}{100}$th of an inch or less. The markings of these divisions come into focus therefore at the same time as the image of the object, and both are distinctly seen together. Thus the measure of the magnified image is given by mere inspection, and the value of such measures in reference to the real object may be obtained thus, which, when once obtained, is constant for the same objective. Place on the stage of the instrument a divided scale the value of which is known, and, viewing this scale as the microscopic object, observe how many of the divisions on the scale attached to the eye-piece correspond with one of those in the magnified image. If, for instance, ten of those in the eye-piece correspond with one of those in the image, and if the divisions are known to be equal, then the image is ten times larger than the object, and the dimensions of the object are ten times less than indicated by the micrometer. If the divisions on the micrometer and on the magnified scale were not equal, it becomes a mere rule-of-three sum; but in general this trouble is taken by the maker of the instrument, who furnishes a table showing the value of each division of the micrometer for every objective with which it may be used.

Fig. 21.



While on the subject of measuring it may be well to explain the mode of ascertaining the magnifying power of the compound microscope, which is generally taken on the assumption before mentioned, that the naked eye sees most distinctly at the distance of 10 inches.

Place on the stage of the instrument, as before, a known divided scale, and when it is distinctly seen, hold a rule at 10 inches distance from the disengaged eye, so that it may be seen by that eye, overlapping or lying by side of the magnified picture of the other scale. Then move the rule till one or more of its known divisions correspond with a number of those in the magnified scale, and a comparison of the two gives the magnifying power.

Having now explained the optical principles of the achromatic compound microscope, it remains only to describe the mechanical arrangements for giving those principles their full effect. The mechanism of a microscope is of much more importance than might be imagined by those who have not studied the subject. In the first place, steadiness, or freedom from vibration, and most particularly freedom from any vibrations which are not equally communicated to the object under examination, and to the lenses by which it is viewed, is a point of the utmost consequence. When, for instance, the body containing the lenses is screwed by its lower extremity to a horizontal arm, we have one of the most vibratory forms conceivable; it is precisely the form of the inverted pendulum, which is expressly contrived to indicate otherwise insensible variations. The tremor necessarily attendant on such an arrangement is magnified by the whole power of the instrument; and as the object on the stage partakes of this tremor in a comparatively insensible degree, the image is seen to oscillate so rapidly, as in some cases to be wholly undistinguishable. Such microscopes cannot possibly be used with high powers in ordinary houses abutting on any paved streets through which carriages are passing, nor indeed are they adapted to be used in houses in which the ordinary internal sources of shaking exist.

One of the best modes of mounting a compound microscope is shown in the annexed view (*fig.* 22), which, though too small to exhibit all the details, will serve to explain the chief features of the arrangement.

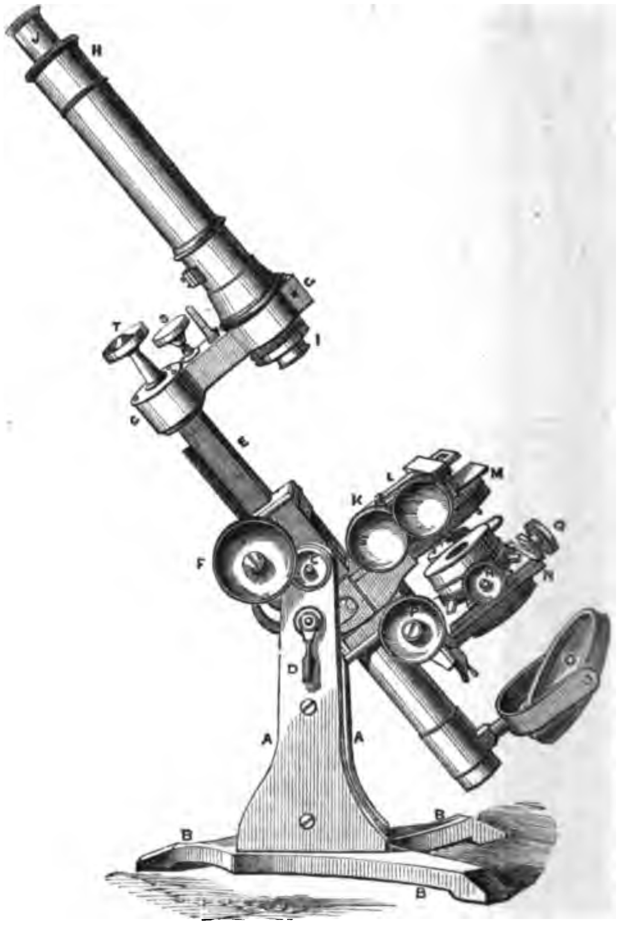


Fig. 22.—Ross's Microscope.

A A are two uprights surmounting the tripod base, B B B. At C is the axis upon which the instrument turns, and by which any inclination, from vertical to horizontal, may be given to it, in which position it may be clamped by the small handle D when the use of over-balancing apparatus on the secondary stage renders this necessary. Motion is given to the bar E by the milled head F: a corresponding milled head on the other side of the instrument may also be used for the same purpose. At the end of the arm G G is fixed the compound tube H G I, which receives at its upper extremity the eye-piece J: at its lower extremity, I, the objective is to be screwed on. K L M, is the mechanical stage upon which the objects under microscopic examination are placed, the milled head marked K giving it a vertical motion, and that marked L a lateral one. This stage has also a rotary motion, concentric with the axis of the compound tube H G I, which enables the observer to examine an object in any position of rotation, keeping the object in the field of view. Fitted to the secondary stage, N, is represented a system of diaphragms employed to regulate the diameter of the pencil of light reflected from either the plane or concave surface of the mirror O. The diaphragms can be removed, and a variety of apparatus substituted. The regulation of the distance between the illuminator and the object under examination is effected by means of the milled head P. Q is one of two milled heads which give motion in rectangular directions to the secondary stage, for the purpose of causing its axis to coincide with that of the compound tube. The milled head marked R communicates a rotary motion to the tube of the secondary stage. In using the higher powers, the instrument is only approximately adjusted by the milled head F, the rack with which it communicates being called the coarse adjustment: the fine adjustment is effected by means of the graduated milled head S, which is connected with a screw and lever acting on the optical arrangement $\frac{1}{300}$ of an inch for each revolution of the milled head S. The milled head T is used to clamp the arm to the bar of the instrument. This description though brief, will be found sufficiently lucid to convey to the mind of the reader correct notions of the mechanical arrangements of the compound microscope.

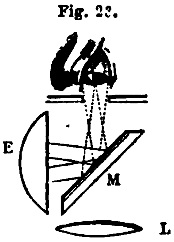
Most of the directions for viewing and illuminating objects, given in reference to the simple microscope, are applicable to the compound. An argand lamp placed in the focus of a large detached lens so as to throw parallel rays upon the mirror, is the best artificial light; and for opaque objects the light so thrown up may be reflected by metallic specula (called, from their inventor, Lieberkhuns) attached to the object-glasses.

On the proposal of Sir David Brewster and M. Dujardin, the Wollaston condenser was achromatised with very excellent effect by constructing it with three pair of achromatic lenses, instead of the single lens before described. Subsequent improvements have been effected by Mr. Gillett, and a modification of the form adopted by that gentleman has been constructed by Messrs. Powell and Lealand Other modes of illumination have also been adopted, such as the prisms of Amici, Nachet, and Powell, Nobert's circular condenser, Ross's spotted lens for dark ground illumination, &c.

The erector commonly applied to the compound microscope consists of a pair of lenses acting like the erecting eye-piece of the telescope. But this, though it is convenient for the purpose of dissection, very much impairs the optical performance of the instrument.

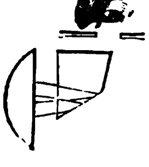
For drawing the images presented by the microscope, the best apparatus consists of a mirror M (*Fig.* 23), composed of a thin piece of rather dark-coloured glass, cemented on to a piece of plate-glass inclined at an angle of 45° in front of the eye-glass E. The light escaping from the eye-glass is assisted in its reflection upwards to the eye by the dark glass, which effects the further useful purpose of rendering the paper less brilliant, and thus enabling the eye better to see the reflected image. The lens L, below the reflector, is to cause the light from the paper and pencil to diverge from the same distance as that received from the eye-glass; in other words, to cause it to reach the eye in parallel lines.

Fig. 23.



Dr. Wollaston's Camera Lucida, as shown in *Fig.* 24, is sometimes attached to the eye-piece of the microscope for the same purpose. In this instrument the rays suffer two internal reflections within the glass prism, as will be seen explained in the article CAMERA LUCIDA. In this minute figure we have omitted to trace the reflected rays, merely to avoid confusion.

Fig. 24.

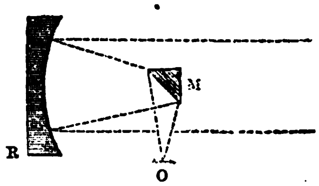


Of late years, the microscopist has availed himself of markings on the frustules of the diatomaceæ as tests for the separating power of his objectives: for a description of these tests we must refer the reader to Smith's 'Diatomaceæ.' Although many objectives possessing large angles of aperture are capable of discovering markings upon diatomes, yet, for definition, the employment of a well-marked scale of Podura is advisable. When circumstances admit of it, opticians test their objectives by means of a disc of light reflected from a small globule of mercury; this test, however, can be depended upon only when employed by the practised and skilful optician, great experience being required to judge of an objective by this means.

For a full description of the nature and uses of the numerous adjuncts to the microscope, we must refer the reader to the valuable works of Quekett, Hogg, and Beale, on that subject.

Although the reflecting microscope is now very little used, it may be expected that we should mention it. In this instrument, at *Fig.* 25, he object O is reflected by the inclined face of the mirror M, and the ays are again reflected and converged by the ellipsoidal reflector R R, which effects the same purpose as the object-glass of the compound microscope. It forms an image which is not susceptible of the over-correction as to colour before described, and which therefore becomes coloured in passing through the eye-piece. This fact, and the loss of light by reflection, will probably always render the reflecting microscope inferior to the achromatic refracting.

Fig. 25.



The *Lucernal Microscope* is a hollow pyramidal box, of wood, at the smaller extremity of which is a tube carrying the usual system of lenses for magnifying objects. At the larger end, which is towards the observer, there are two lenses in frames; their axes, as well as those of the small lenses at the opposite extremity, being coincident with the axis of the box; and between the exterior of the two lenses and the eye of the observer there is usually placed a plate of glass, rough-ground on one side, which serves as a screen to receive the rays of light proceeding from the object whose representation is to be viewed: the object is fixed in a small frame, as usual, and is placed in a groove made for the purpose immediately beyond the tube containing the system of lenses, at the small end of the pyramidal box.

This box, the axis of which is in a horizontal position, is mounted on a brass stand, which may be placed on the floor or on a table, and the parts of the apparatus are capable of being correctly adjusted by means of screws. The instrument was invented by Mr. George Adams, a distinguished optician in London, and it received its name from the images of the objects being projected on the ground-glass screen by the rays of light transmitted from a lamp through the lenses, the observations being made by night or in a darkened room.

The correct definition of the image depends upon the achromatism of the lenses at the object end of the instrument, a subject which has been treated in the previous part of this article: and therefore it will be sufficient to notice here only the means employed to enlighten the field of view.

For this purpose, in general, an Argand lamp is placed beyond the object, with respect to the microscope; or, if thought necessary, two or more such lamps may be so situated: the light, after passing through a hemisphere of glass, is, when an opaque object is to be viewed, made to fall in a convergent state upon a small concave mirror, which is so inclined as to reflect the light back upon the object; and from the different points on the surface of the latter the pencils of rays proceed through the object-lenses and the box to the glass screen.

By the refraction of the light in passing through the lenses a highly magnified image of the object is formed; and several persons may then place themselves so as to see the image on the screen at the same time; or, by placing the eye at a small aperture in the produced axis of the instrument, one person may, with a pencil, draw on the glass, or on tracing-paper laid over it, the figure of the object; it being understood that, by means of the proper adjusting-screws, the rays in each pencil are made to unite accurately in one point on the screen.

When the object to be viewed is transparent, the light is made to fall in a condensed state upon it, after having been transmitted through a convex lens, or two such; and, from the object, the rays proceed as before to the screen through the system of lenses which constitute the compound objective of the microscope, and through those at the opposite extremity of the box.

Instead of having a plate of ground-glass to receive the image, the pencils of light from the object, after passing through the lenses, may be allowed to fall on a board painted white or covered with white paper; the distance of the board from the instrument (about 6 or 8 feet) being such that the rays in each pencil may converge to a point upon it: thus there will be obtained a greatly magnified image of the object, which may be observed by many spectators at one time. Such a screen should have the form of a segment of a hollow sphere, the light being received on its concave surface; for by that construction the image will be nearly equally distinct at the centre and about the margin.

The *Solar Microscope*, which was invented by Dr. Lieberkhun, in 1738, produces a greatly magnified image of a small object in a similar manner by means of the sun's light. It consists of a conical tube fixed by its base to a frame of wood; the latter being screwed to a closed window-shutter at an aperture purposely made in the latter: the tube projects into the room, which, when the observations are to be made, is rendered quite dark, and is sometimes lined with black cloth. The magnifying power is produced by a system of lenses contained in the tube, as in other microscopes. On the exterior of the window is a frame carrying a rectangular piece of looking-glass; this frame is attached by a joint at one of its sides to a ring of wood or brass which is made to surround the aperture in the shutter. The mirror, by turning on the hinge, is capable of being fixed at any angle with the wall of the building; while the ring to which it is attached can, by means of a rack and pinion, be made to turn on the horizontal axis of the instrument, so as to permit the rays of the sun, whatever be the position of the latter, to be reflected into the tube. By means of lenses disposed for the purpose, these rays are made to converge on the object; and from thence after refraction through the system of object-glasses, they proceed to a screen on which they depict the magnified image.

When the object is transparent, the rays of solar light are allowed to pass from the mirror directly through the lenses to the screen; but when it is opaque, a convex lens placed at the aperture in the window-shutter causes the solar rays to condense on a small mirror placed in a box at that end of the instrument which is within the room, and from this mirror the rays are reflected to the object. The condensed light thus thrown on the object diverges from thence and passes through the system of lenses, by refraction in which the magnifying power is produced; these lenses being placed in a tube which, as well as the object, is within the box containing the mirror last mentioned, but a little above the latter, so that the rays of light proceeding from the object to the magnifying lenses may not be intercepted.

The mirror by which the sun's light is reflected into the instrument is sometimes connected with a clockwork apparatus, by which its position is continually varied correspondently to the apparent change of the sun's place; and thus the reflected light is made constantly to pass through the tube. [HELIOSTAT.]

Sir David Brewster has given, in his 'Treatise on New Philosophical Instruments,' p. 405, &c., a method of preparing objects of natural history for observation by the microscope, that their parts may preserve their proper shape and colour, and thus be seen to the greatest advantage.

In the oxy-hydrogen microscope which is now more generally used, the chief effect is to throw an intense light upon the object, which is sometimes done by mirrors, and sometimes by lenses.

In *Fig.* 26, L represents the cylinder of burning lime, R R the reflector, which concentrates the light upon the object O O; the rays from which, passing through the two plano-convex lenses, are brought to foci upon a screen placed at a great distance, and upon which is formed the magnified image.

Fig. 26.

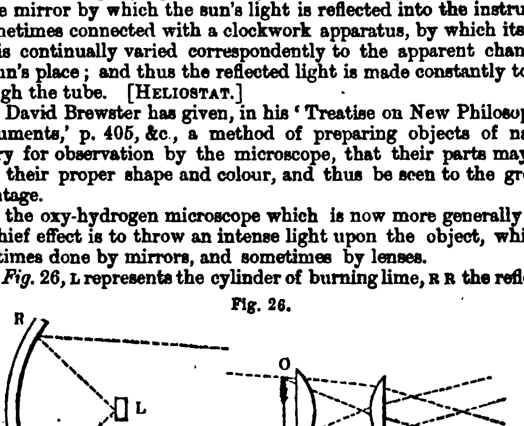
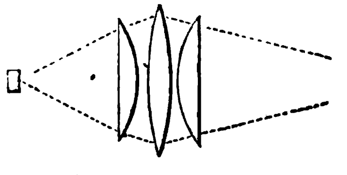


Fig. 27 shows a combination of lenses to condense the light upon the object. In either case the optical arrangements by which the image is formed admit of the same perfection as those which have been described for the compound microscopes. A few achromatic glasses for oxy-hydrogen microscopes have been made, and they will ultimately become valuable instruments for illustrating lectures on natural history and physiology. One made by Mr. Ross was exhibited a few years ago at the Society of Arts to illustrate a lecture on the physiology of woods. It should be observed however that both the oxy-hydrogen and solar microscopes require either a spherical screen, or that the objects should be mounted between spherical glasses, in order to bring the whole into focus at one time. This latter plan was adopted on the occasion just mentioned with perfect success.

Fig. 27.



MICROSCOPIUM (the Microscope), a constellation of Lacaille, situated above Grus and Indus, at the junction of Capricornus and Sagittarius. The only star in it worth notice is α, of the 4½ magnitude, (307) in the catalogue of Piazzi.

MIDDLE LATITUDE SAILING. [SAILING.]

MIDDLE VOICE is a term employed in Greek grammar to indicate a class of verbs which are called reflective in some other languages. The reflective meaning is supposed to be the original and main signification of the middle voice, but it is difficult in many of the middle verbs in Greek to trace the reflective notion. Although a separate voice, that is, a distinct mode of conjugation, has been assigned to verbs with a middle signification, there are only two tenses in the Greek verb which have a form peculiar to the middle notion, namely, the first and second aorists in σαμην and ομην; which in the model verb, are ἐτυψάμην and ἐτυπόμην. There are four tenses peculiar to the passive signification, namely, the two futures in θησομαι and ησομαι, and the two aorists in θην and ην (τυφ-θήσομαι, τυπ-ήσομαι, ἐτύφ-θην, ἐτύπ-ην). The future in σομαι (τύπ-σομαι, λέγ-σομαι), which is called in most grammars the future middle, has a passive signification, as well as a middle. (Monk on Eurip. 'Hippol.' l. 1458; 'Quarterly Journal of Education,' vol. iv. p. 158.) The following table will make the matter clearer :—

Tenses common to the passive and middle significations.

Present	τύπτομαι.	Perfect	τέτυμμαι.
Imperfect	ἐτυπτόμην.	Past Perfect	ἐτετύμμην.
Future	τύψομαι	Future Perfect	τετύψομαι.

Tenses peculiar to the middle signification.

1st Aorist	ἐτυψάμην.	2nd Aorist	ἐτυπόμην

Tenses peculiar to the passive signification.

1st Aorist	ἐτύφθην.	2nd Aorist	ἐτύπην.
1st Future	τυφθήσομαι.	2nd Future	τυπήσομαι

Since then so many tenses in the Greek verb have the same form both for the middle and passive signification, it becomes an interesting object of inquiry, whether we should assign the priority to the passive or middle notion. This question has usually been answered by grammarians in favour of the passive; but the comparison of other languages etymologically connected with the Greek, would lead us to a contrary supposition. Very few of the Indo-Germanic languages have a form peculiar to the passive signification; even in Sanskrit the passive verb is not considered by Hindu grammarians as a distinct voice, but is classed among the derivative verbs. There are however two voices in the Sanskrit verb, answering to the Greek active and middle, which are called respectively *parasmaipadum* and *atmanêpadum;* the former answering to the active in Greek, and the latter having generally a reflective or medial but never a passive signification. The tenses of the passive verb are formed by prefixing the syllable ya to the person endings of the *atmanêpadum* conjugation. These person endings are evidently the same as those of the middle voice in Greek, as the following table of the present tense will show :—

	Sanskrit.	Greek.
Singular.	kship-ê	τύπτ-ο, μαι.
	kship-a, sê	τύπτ-ε, σαι (afterwards τύπτ-εαι = τύπτ-ῃ).
	kship-a, tê	τύπτ-ε, ται.
Dual.	kship-â, vahê	τυπτ-ό, μεθον.
	kship-ê, thê	τύπτ-ε, σθον.
	kship-êtê	τύπτ-ε, σθον.
Plural.	kship-â, mahê	τυπτ-ό, μεθα.
	kship-a, dhê	τύπτ-ε, σθε.
	kship-a, ntê	τύπτ-ο, νται.

That the passive signification should in course of time have taken the place of the middle, will not appear surprising, when it is recollected that a reflective verb is actually used in many languages, where a passive is used in others to express the same thing. An instance occurs in such a phrase as *les bas se vendent ici*, stockings sell themselves here; and in the same manner in Italian we have such phrases as *si dicono molte cose*, many things say themselves, or are said; *si loda l'uomo modesto*, a modest man praises himself, that is, is praised; *mi si domanda uno scudo*, a dollar demands itself of me, that is, is demanded of me. The same idiom occurs both in Spanish and Portuguese.

It has been the practice to deny to the Latin language the possession of a middle, except in the case of deponent verbs. But in such a phrase as *Rhenus Oceano miscetur*, the verb is rather of the middle than the passive character, and this certainly must be allowed when it is said of a soldier *induitur galeam*, or when a general *milites armari jubet;* or as in the line of Virgil ('Georg.,' iii. 219)—

Pascitur in magna sylva formosa juvenca.

The above explanation of the middle form or voice is one which has been proposed; still the matter may require further discussion. The truth is, that the classification of verbs into active and passive, or into active, passive and middle, is a very imperfect one, and for the purposes of a philosophical exhibition of grammar a new classification is wanting. The expressions "I walk," "I eat," &c., are in signification allied to the middle voice, though the form of these words does not differ from the form "I kill," "I cut," &c. In order to express the notion of the person "I" being "killed," some modification of the primitive form "kill" must be made, and another modification may be necessary to express the act of "self-killing." Thus in French we have *il tue, il fut tué,* and *il s'est tué.* In the last instance the act of "self-killing" is distinguished from the act of "being killed" by the addition of a word. In the Greek language the present tense of the passive form may be used to express either the act of the person being killed, or killing himself. In the first and second aorist tenses a peculiar form is used to express the act of self-killing; but as this peculiar form has the characteristic termination of what is called a passive verb, and not of an active, it might be classed under the passive voice as a peculiar tense, and the term middle voice might be got rid of altogether.

MIDHEAVEN (Astronomy), a technical term for the point of the ecliptic which is on the meridian at any given moment.

MIDIANITES (מִדְיָנִים, *Μαδιανίται, Μαδιηναῖοι*), the descendants of Midian, the son of Abraham by Keturah (Gen. xxv. 2, 4), who, with the other sons of Abraham's concubines, migrated eastward from Canaan during Abraham's life (Gen. xxv. 6). In the time of Jacob their merchants had caravans from Gilead through Palestine to Egypt (Gen. xxxvii. 28, 36). In the time of Moses we find them in Arabia Petræa, under the government of a high-priest (Exod. ii. 15), and leading their flocks as far as Mount Sinai (Exod. iii. 1); but they did not extend to the west of this mountain, for the Israelites did not come in contact with them in their march from Egypt, but, on the contrary, Jethro, their high-priest, came out of his country to visit Moses, when the Israelites were encamped at the foot of Sinai (Exod. xviii. 1-5; Numb. x. 29). They subsequently frequently harassed the Israelites till Gideon defeated them and the Amalekites in the plain of Jezreel, and pursued them beyond the Jordan. They were still known, however, in the time of Isaiah (lx. 6) as a commercial tribe.

The exact country of the Midianites is not determined with certainty. Some, indeed, suppose that those in Arabia Petræa, mentioned in Exodus (ii. 15) were quite a different nation from those on the east of Palestine, the former being related to the descendants of Cush, the son of Ham (Numb. xii. 1; Hab. iii. 7). But the more common and more probable opinion is, that the Midianites were all descended from the same stock, and those on the Ælanitic Gulf were sometimes called Ethiopians, while those near the Dead Sea are occasionally called Ishmaelites; and there may have been other bodies of them in the western part of Arabia (1 Kings, xi. 18). The Arabian geographers Abulfeda and Edrisi mention a town, Madian, on the eastern side of the Ælanitic Gulf of the Red Sea, somewhat to the north of the modern Moilah, which is probably the *Μήδιανα* of Ptolemy (v. 17) and the *Μαδιανή* of Josephus ('Ant.' xii. 11, 1), and of which the ruins were to be seen in the time of Eusebius and Jerome.

The Midianites were governed by their elders (Numb. xxii. 4), and by chiefs or kings (Numb. xxv. 15, 18; xxxi. 8; Judges, vii. 25; viii. 3, 5). They possessed many camels, and had acquired great wealth, probably by commerce (Judges, vi. 5; vii. 12; viii. 10, 24; Is. lx. 6). Their religion was the worship of Baal-peor.

MIDSHIPMEN are young gentlemen ranking as intermediate between 1st class petty officers and warrant officers on board a ship of war. Their duty is to pass to the seamen the orders of the captain or other superior officer, and to superintend the performance of the duties so commanded. They are educated for their profession at the Royal Naval College, and commence their career in the service as naval cadets between the ages of 12 and 14. The whole system of entering, educating, and promoting junior officers in the navy has recently undergone complete revision. To qualify them for promotion as lieutenants, they must be able to pass a proper examination in seamanship and navigation, be of the full age of 19, and have passed a period of 5½ years in her Majesty's navy.

The monthly pay of an officer of this class is 2*l.* 14*s.* 3*d.* in ships of all rates.

MIDSUMMER EVE. On the eve of the feast of the Nativity of St. John the Baptist, or Midsummer-day, it was long the custom in England to kindle fires at midnight, sometimes upon the hills, in honour of the summer solstice; a practice which Gebelin, in his 'Allegories Orientales,' says was followed among the ancient nations. The same practice has prevailed in many other countries, accompanied with superstitious observances, evidently the relics of some very ancient time, and now generally fallen into desuetude. (Brand's *Popular Antiquities*, Sir H. Ellis's edit., vol. i., 1841.)

MIGNONETTE (*Reseda odorata*) is a common garden flower, with lanceolate bluntish entire or trifid leaves, and a 6-parted calyx equal in length to the petals, which are finely cleft into many club-shaped divisions, the two lowest simple, the capsules 3-toothed. It is a native of the north of Africa and Egypt, but its delicious fragrance has caused it to be cultivated all over the world. It is naturally an herb, but when trained in the greenhouse it becomes shrubby. This plant is in great demand in the London markets, and is very extensively cultivated. The seeds should be sown in the ground in April, on a bed well manured with rotten dung. As the plants rise they should be thinned by degrees, so as to leave them from 9 to 12 inches apart. They must be well watered, and require abundance of sun and air. Before they come into bloom nip off the centre shoots, after which the side shoots will fill the vacant spaces, and form a full and very pretty bed. If sown in pots or boxes, a mixture of rotten turf and cow-dung, of which the larger portion should be of the turf, must be placed for the reception of the seed, and the plants should be treated as above. Transplanting seldom succeeds. This is the common garden culture, and the plants flower in June. In a forced culture, for flowering from December to February, a sowing should be made in July, in the open ground, and the plants potted in September and removed in-doors. The crop for March, April, and May should be sown in pots not later than the 25th of August. The plants from this sowing will not suffer from exposure to rain whilst they are young; they must however be protected from early frosts, and are to be thinned in November. At the same time the pots should be sunk 3 or 4 inches in some old tan or coal-ashes and should be covered with a frame, which it is best to place fronting the west, for then the lights may be left open in the evening, to catch the sun whenever it sets clear. The third or spring crop should be sown in pots not later than the 25th of February. These must be placed in a frame on a gentle heat; and as the heat declines, the pots must be let down 3 or 4 inches into the dung-bed, which will keep the roots moist, and prevent their leaves turning brown from the heat of the sun in April and May. The plants thus obtained will be in perfection by the end of May.

The arborescent plant is often called Tree-Mignonette. It may be propagated by seeds or by cuttings, which readily strike root. The young plants should be potted singly, and brought forward by heat. As they grow they should be tied to a stick, and all side shoots should be pinched off. As the plants attain a greater size they should be shifted progressively into larger pots.

MILE. This word is derived from *miliare*, the *mille passus*, or thousand paces, of the Romans. Each pace was 5 feet, and each foot certainly contained between 11·60 and 11·64 modern English inches. [Weights and Measures.] Taking the Roman foot at 11·62 English inches, the original Roman mile was therefore 1614 yards, or nine-tenths and one-sixtieth of an English statute mile, very nearly; while the English mile is a Roman mile and nine-hundredths of a Roman mile, very nearly.

The English statute mile is 8 furlongs, each of 220 yards, or 40 poles of 5½ yards or 16½ feet each. It is also 80 surveying chains of 22 yards each. It is therefore 1760 yards, or 5280 feet. The square mile is 6400 square chains, or 640 acres.

The remains of the Roman mile and the Gallic or Celtic league [League] are found in the itinerary measures of most European countries. The following list (taken from Kelly's 'Cambist,' except the statement of the Roman mile) will show the itinerary measures of various countries, as they are usually reputed in English yards and statute miles. We have placed them in order of magnitude. The last column shows in round numbers how many of each make 1000 statute miles:—

Yards.		Stat. miles.	No. in 1000 stat. miles.
1614	Ancient Roman mile . . .	·917	1091
1628	Modern Roman mile . . .	·925	1081
1760	English statute mile . . .	1·000	1000
1808	Tuscan mile	1·027	974
1984	Ancient Scottish mile . .	1·127	887
2240	Irish mile	1·273	786
4263	French posting league . .	2·422	413
4635	Spanish judicial league . . .	2·634	380
4860	French league of 25 to the degree	2·761	362
6760	Portugal league . . .	3·841	260
6859	German short mile . . .	3·897	257
6864	Flanders league . . .	3·900	256
7416	Spanish common league . .	4·214	237
8237	Prussian mile	4·680	214
8244	Danish mile	4·684	213
8475	Dantzic mile	4·815	205
9113	Hungarian mile	5·178	193
9153	Swiss mile	5·201	192
10126	German long mile . . .	5·753	174
11559	Hanoverian mile . . .	6·568	152
11700	Swedish mile	6·648	150

The metrical mile of 1000 French metres, or one kilometre, or 1093 English yards, is put down among the measures of France, Italy, and the Netherlands; the geographical mile, or the sixtieth of a degree of latitude, or about 2025 yards, is used in England and Italy; the geographical league of three such miles, or 6075 yards, is used in England and France; the German geographical mile is four English geographical miles, or 8100 yards; the short mile used in Poland (which is also the league of Brabant) is the geographical league (6076 yards), and the long mile of the same country is the German geographical mile (8101 yards), which is also the length of the mile in Holland. The Arabian mile is 2148 yards; the Chinese li 632 yards; the Persian parasang 6086 yards; the Russian werst 1167 yards; and the Turkish berri 1826 yards. All the preceding statements relative to modern measures rest on the authority of the work cited.

This diversity of itinerary measures, particularly as observable in countries which were formerly under Roman sway, can only be conjecturally explained; partly by supposing that the mile (Roman) and the league (Celtic) were in process of time confounded with each other (as Ingulphus asserts to have been the case in England), partly by recurring to the well-known tendency to give the same name to measures which were multiples one of the other. [League.] It would be much beyond us to attempt any derivation of the preceding anomalous measures, either from the mile or the league, and we shall in the present article confine ourselves to the history of the English mile.

It will be necessary to treat this subject at some length, on account of the manner in which our metrologists and antiquaries have passed it over. The legal history is simply this; that previously to the reign of Elizabeth the statutes on weights and measures confined themselves entirely to the regulation of the smaller standards; while in the 35th year of that queen an act was passed which (perhaps undesignedly on the part of its framers) has fixed the mile at its present length. This statute, though it is always appealed to as if made for the purpose of settling the question, yet in fact does nothing more than incidentally define a mile for a particular purpose. Persons are forbidden to build within three *miles* of London, and the *mile* is to be 8 furlongs of 40 perches of 16½ feet each. But whether this mile had become common, and only wanted the sanction of law, whether it was a new measure intended to be generally enforced, or whether it was meant as the measure for the particular purpose indicated, and for that purpose only, cannot be gathered, at least from the recital in the Statutes at large. It will however subsequently appear that we are not without something like a probable account of the derivation of the measure; and whatever doubt may rest upon the meaning of the statute, it was considered by an authority of the reign of James I. (Cowell) as a general declaration of the length of the mile. Previously however to the act of Elizabeth it may be doubted whether any uniform mile was in existence. Most unquestionably many, perhaps most, writers made use of a mile of 5000 feet, probably not being aware of the English foot having become longer than the Roman, and intending to use the Roman mile. (See the citations in LEAGUE.) Thus, Roger Bacon, in his general description of the earth, follows (except as hereinafter mentioned) the Latin writers, and uses their mile as a matter of course, without the least warning of his being aware that he was using a measure different from the popular one of his time. Accordingly, in a writer on any mathematical or cosmographical topic the mile may be presumed to have 5000 feet. If however the subject had any connection with astronomy, and if Arabian writers were referred to, it was not unusual to use the Arabian mile of 2000 yards (according to Roger Bacon's estimation, Jebb, p. 141).

If, as we believe we shall presently show, a longer mile were in popular use, it may be doubted whether the authors above alluded to were aware of the difference. They certainly did not perpetuate such knowledge; for Dr. Bernard, the most profound of English metrologists, found the mile of 5000 feet sufficiently common in old writings to induce him to give it a name, and call it the English *geometrical* mile, meaning, we suppose, that principally used in mathematical writings; but he does not give the least hint that any other mile, except this geometrical mile and the statute mile, was ever in existence. Nor does his predecessor Greaves, when he remarks that great differences have been observed between measured and statute miles, hint at such discordances being derived from the remains of any old and different measure, or at any acknowledged measure different from the statute mile. This mile of 5000 feet continued in use among seamen, whose measures depend more upon writers on navigation than on acts of parliament, until the earth's dimensions became better known. A very old notion as to the earth's magnitude gave 60, or at most 62½, Roman miles to the degree. The sea mile tallied with that of writers on shore, until the measures of Picard, &c., became well known; but the sixtieth part of a degree of latitude is so convenient a standard measure for the sailor, that under the name of a nautical or geographical mile it has lengthened with the common estimation of the degree of latitude. Thus, in the time of Gunter we find the degree described as 60 miles of 5000 feet each; though he certainly says (*On the Cross-Staffe*, b. xi., cap. 6), that by comparison of observations,* he thinks 352,000 feet nearer the truth. Even almost as late as the Revolution some common works written for landsmen describe the sea league as three Italian miles, which answers nearly to 15,000 feet. By the time of Dr. Bernard however we find the sea mile described as coinciding with the statute mile (*De Mens. et Pond.*, p. 202); but this is in a work of science and authority: and Oughtred (before the date of Bernard's book) says that it is "taken (or rather mistaken) that 60 statute miles make a degree." It is most likely that the sea league would in the first instance be taken from the common league; and certainly 15,000 feet, or 2·84 statute miles, is almost the same as the length which different deductions will give for the old land league.

We now proceed to the main question, the length of the old English mile: premising that the utmost we can attempt is a clear proof that the old popular mile differed considerably from the modern mile. The gradual changes of this old mile (which the general history of itinerary measures may lead us to suspect) must be traced out by closer investigation of antiquarian authorities than mathematicians have been wont to make, and better estimation of their relative values in a mathematical point of view than antiquaries have hitherto been capable of making.

There is a *tradition* among antiquaries (Sir H. Ellis, 'Preface to Domesday') that this old mile was somewhere about a statute mile and a-half. This tradition is not to be relied on; for though in all probability it agrees with the truth, yet it may have arisen from another circumstance. We have more than once heard it proved by the assertion that, even within the memory of man, distances were measured in the remote parts of the country by a longer than the statute mile; for instance, that York was said to be 150 miles from London, while it is really more than 199 statute miles. This is perfectly true; but the reason is perhaps different from that given, as the following account will show:—

The first actual measurement of the roads in England, in statute miles, was made by John Ogilby, cosmographer to Charles II., and was published by him in 1675, under the title of 'Britannia,' with copious descriptions, and 100 copper-plates of the roads, in a large folio volume: the instrument used was called by him a *wheel-dimensurator*, by others, a *way-wiser*, and answers entirely to the perambulator now in use. Various editions of this work were published, of which we have seen three, and D'Anville mentions a fourth. It is worth noting that this measurement, as compared with older ones, soon came into general use: thus in a little work for men of business, called 'The Complete Tradesman, or Exact Dealer's Daily Companion,' London, 1684, we find a list of Ogilby's distances from town to town, compared with those formerly adopted. The latter were called by Ogilby *computed* miles, and the meaning of this word might be doubted, but it is proved to mean miles in common use by previous publications. Thus in Samuel Morland's 'Description and Use of Two Arithmetic Instruments,' &c., 1673 (or two years before Ogilby's publication), we find the distances called "computed" by Ogilby set down as the (supposed) real distances. D'Anville appears to have seen an edition of Ogilby (of which there is one at least) in which the word *computed* is always contracted into *com.* This he supposed to mean *common*, and the whole of his chapter on English itinerary measures ('Mésures Itinéraires,' cap. x.) must in consequence be read cautiously, as he assumes to be indisputable that there was a common mile in use at the Revolution, which was about a quarter longer than the statute mile. But on the authority of the silence of Bernard and Greaves above referred to, we must remain of a different opinion, and must suppose that the computed miles preserved by Ogilby had been intended to represent the number of statute miles, but erroneously given.

What then may these computed miles mean, which had served the common purpose in the estimation of distances? The word computed never meant reputed, but was always applied to a result of reckoning of some kind or other. Ogilby says, "Whence these computations arose is altogether uncertain; the nearest conjecture is, that they seem to exclude the whole length of the towns, and to be the distance from the end of one town to the beginning of the next, not regarding the fractional parts of a mile, but taking the lesser integer." The computed miles always give a smaller figure than the measured ones, or the same, never a greater; and a little examination will render it difficult to suppose that the preceding explanation can be the true one. For independently of its having been the known practice to measure the roads from a conspicuous part of every town, the preceding will not explain differences of four, five, and even seven miles in a stage of less than thirty; neither will it explain long stages being often of the same number of computed as of measured miles. Our own conviction is that the computed miles are nothing more than distances measured on a map in a straight line from town to town, which differ from those measured on the roads more or less, according to the deviations and curvatures of the roads. Should this opinion be correct, we might expect beforehand, first, that the roads in the neighbourhood of the metropolis would appear more direct than the general average; secondly, that the principal roads would show indications of being more straight than the average deduced from all classes, and from cross as well as direct roads. Both these things appear in the general results, and we can clear ourselves of the suspicion of bias in our selection of instances by throwing that task on others. In the first place the roads near London agree so much better in the computation, so called, and the measurement, that both Ogilby and D'Anville notice the circumstance, and conclude that a shorter mile was in use in the neighbourhood of the great city. We find on examination that such is the case with most of the twenty-mile distances about London, which yield about 120 measured miles for 100 computed miles; and this happens particularly with those routes which come earliest in Ogilby's work; but 120 would have been increased almost up to the general average by taking twenty miles on every road out of London.

Secondly, in the 'Exact Dealer's Daily Companion,' already quoted, there is a selection of the roads to which most importance was attached, upon the whole of which 3953 computed miles answer to 5020 measured miles, or 100 computed miles give 127 measured miles. According to D'Anville, Ogilby's whole work gives 7679¼ measured miles of road, and 5765 computed, so that 100 computed miles make 133 measured miles. Hence the remaining 2659 measured miles give 1812 computed miles; or, off the principal roads, 100 computed miles give 147 measured miles. These results place, in such large numbers of miles, insuperable difficulties in the way of any explanation which should equally apply to the greater and lesser roads; and it seems to us that there remains only the hypothesis that the computed miles were map-measured distances, and that the larger and more important roads were straighter than the rest. If our hypothesis be correct, these computed miles should represent distances on an incorrect map, which in fact they do. We found them agree somewhat better with the county maps in old editions of Camden's 'Britannia' than with our modern maps. And long after this article was written, we found that our explanation not only had been given, but was at one time so common as to admit of reference as to a thing understood. Dr. Grew, in a paper in the 'Philosophical Transactions' (1711), speaking of some erroneous "under-reckoning" says, "their mistake seems to have been, their reckoning only by the maps; that is, by computed and not by measured miles."

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* This of course refers to the measure of Snell, which gave 353,285 feet (A.D. 1616).

It is believed that, since the time of Ogilby, the roads have been much shortened by the various acts of parliament. *Have the mile-stones been always altered accordingly?* or was the increased speed of stage-coaches, towards the end of their career, in part the result of calling a shorter line of road by the same number of miles? To try this question, we shall compare a few distances from place to place, as given in Ogilby's 'Britannia,' with those in Mogg's edition of Paterson's 'Roads' (1824), altered so as to start from the same point, namely, the old standard in Cornhill:—

	Ogilby.	Mogg.
London to Worcester	112	114
„ Berwick	339	337
„ Bristol	115	117
„ Bridgnorth	142	142

The measures in Ogilby may of course be erroneous; but as they were certainly made with a sufficient instrument, and exhibit every appearance of care, and as in our country it is nobody's business to see that all succeeding milestones are altered when a mile of road is saved in the middle of a line, we suspect strongly that a remeasurement would often show the distances of 1824 to be too long. And in truth the four distances just given are now said to be of 111, 337, 108, and 138 miles.

The credit of the antiquaries' tradition, which would otherwise be considerable, is destroyed by its probable origin, as above stated. We now come to another species of evidence, the testimony of foreign writers. The new measures of any country found their way abroad but slowly at the beginning of the 17th century, and we shall not therefore be surprised to find foreign writers of the middle and end of that century varying from then existing measures in their statements. We shall first take the geography of Varenius, first published in 1650, and edited in 1672 by no less a person than Newton, then Lucasian professor. The following sentence was allowed by the editor to pass without comment:—"Triplicia habent Angli milliaria: majora, quorum 27½ æquant gradum sive 19 Hollandica; mediocria quorum 50; minima quorum 60 vel 55." Now the mile of Varenius is described by himself as containing 18,000 Rhineland feet, each of which, according to Dr. Bernard, is 1·033 English feet. Whence it may be deduced that the three miles described as English by Varenius severally contain 2·43, 1·33, and 1·11 statute miles (taking "60 vel 55" to be 60). We have no doubt that Varenius has here got hold of the leuca, the old mile or half the leuca, and the modern statute mile, which, being not sixty years old when he wrote, was not, though the contemporary legal measure, more accurately known than the others. Again, Ozanam, in his 'Mathematical Dictionary,' 1691, makes the English mile a quarter longer than the Italian mile, that is, considerably above the statute mile; but his accounts of itinerary measures are so evidently theorised into round hundreds and thousands of geometrical paces, that no dependence can be placed on any specific results drawn from them. If his geometrical pace be five French feet (Paucton, p. 179), this English mile (which he states at 1250 paces) is 6250 French feet, or 2219 English yards, that is, 1·26 statute miles. But this is hardly worth notice, for no value of the geometrical pace can be taken which will make Ozanam's account of measures consistent with itself. We shall take one more conjectural determination of the mile, derived from the sea league of the 17th century. Gunter states this at three miles of 5000 feet in a mile, the league being the twentieth of a reputed degree. The author of the 'Exact Dealer's Daily Companion,' above cited, calls it three Italian miles, or 4904 yards. Now if the original league were the land measure, then the mile (or half of the leuca) would have been 2452 yards, or 1·4 statute miles.

D'Anville endeavours to make the old mile the same thing as the original French league, or the Roman mile and a half [LEAGUE], taking the *computed mile*, already discussed, as the old measure. But independently of the mile thus considered not being long enough (and we have no instance of an itinerary measure shortening by time), the distinction between the mile and the league seems to have been one of the most common notoriety from the time of the earliest manuscripts; and previous to this time the confusion which might have made D'Anville's supposition true had already lengthened the league by 500 paces.

The only way of detecting the length of any measure, a copy of which is not absolutely preserved, is by the knowledge of some quantity, which having been handed down in terms of the old measure, and being still in existence, can be re-estimated in terms of the new measures. Unfortunately we have no very exact measurements of well-known lengths; nevertheless by using such as we have, and taking the mean of a considerable number, the odds are much against any very serious error remaining in the result.

About 1478 William Botoner, commonly called William Wircestre, or William of Worcester, made a tour in various parts of England, and wrote, apparently for his own use, a large number of memoranda, which remained in the library of Corpus Christi College, Cambridge, and were published in 1778, by Dr. Nasmyth, with the title,* 'Itinerarium Willelmi de Worcestre.' The date of the writer is well settled, for he asserts that in the year 1473 he presented to the bishop of Winchester his own translation *into English* of Cicero de Senectute. This William of Worcester was given to measurement: he records the dimensions of the churches which he visited, and the numbers of miles between the several towns. From the latter enumerations we have collected the most definite instances, which we have compared with our latest road-books, as follows (W is the number of miles in W. of W.'s account; R in the road-books):—

	W.	R.
From Oxford to Farringdon	12	17½
„ Farringdon to Wotton Basset	15	19
„ Gloucester to Tewkesbury	7	11
„ Shepton Mallet to Glastonbury . .	5	8½
„ Glastonbury to Bridgewater . . .	9	15½
„ Bridgewater to Taunton	7	11½
„ Taunton to Wellington	5	7
„ Wellington to Collumpton	10	12½
„ Collumpton to Exeter	10	11½
„ Ottery St. Mary to Exeter	10	13
„ Plymouth to Saltash	3	4½
Totals	93	131½

To give the best chance of a correct result which our present means afford, we must increase this 131½ modern road miles in such proportion as will make them correctly represent the same roads at the time when William of Worcester travelled. This we have no data for doing, and any supposition we may make must rest on its own intrinsic probability. To neglect this correction altogether would make the preceding give 100 old miles equal to 141 statute miles, and this is the lowest conclusion which can be formed. But if five per cent. of deviation has been corrected since the old account, that is, if what is now 100 miles would have been 105, then 100 old miles may be stated at 148 statute miles. This conclusion, and even a stronger one, may be reinforced from a totally distinct quarter. But first let it be observed, that since roads have no tendency to lengthen, but the contrary, it may be inferred that such of the preceding instances as make the old mile least are most probably those in which the distances have been shortened; and instead of being the cases of most weight, are precisely the reverse.

Though the preceding instances are quite sufficient, yet it may be satisfactory to name one or two short distances in which a very large mistake is impossible. The following, were they the only ones, would lead us to suspect that the old mile was even longer than a mile and a half statute. William of Worcester says that Wokey Hole is about half a mile from Wells, whereas, by the Ordnance Map, it is a mile and six-tenths in a straight line from the centre of the town. Again, Merkysberry (now Masberry) Castle is placed by him at two miles from Wells on the opposite side: it is now three miles and three-quarters in a straight line from the centre of the town. Lastly, Fenny Castle is said to be a mile and a half westward towards the marsh, whereas what is now called Castle Hill is two miles and three-quarters westward. These instances are more convincing than the preceding as to the mere use of a longer mile, though not so well adapted for its determination.

We must now remove the question to Palestine. In the description of the earth given by Roger Bacon (Jebb, pp. 180-236) he generally follows Pliny, and gives distances in Roman miles, except only when treating of those parts which the Crusaders visited, and other Eastern countries. In this part of his account Bacon relies much on the conversation and writings of a certain Willielmus, who went on a mission from the king of France to the Tartars (Turks), in 1253, and on the oral accounts of other travellers. But the country on the distances of whose towns he is most precise in his information is Palestine itself. By taking fifteen well defined instances, and measuring the corresponding distances on Major Rennell's map in parts of inches, we have the following, the first column being the number of leucæ in Bacon, the second the number of inches in Rennell. (We omit sea-distances, as likely to err considerably.)

	B.	R.
From Gaza to Ascalon	9	·65
„ Ascalon to Joppa	12	1·12
„ Joppa to Aco	24	2·48
„ Aco to Cæsarea	12	1·10
„ Aco to Tyre	9	1·18
„ Tyre to Sarepta	4½	·49
„ Sarepta to Sidon	3½	·34
„ Sidon to Baruth	8½	1·10
„ Baruth to Gibeleth	9	·87
„ Gibeleth to Tripolis	9	1·21
„ Jerusalem to Joppa	12	1·30
„ Jerusalem to Jericho	9	·67
„ Samaria to Jerusalem	12	1·57
„ Samaria to Cæsarea	12	1·03
„ Aco to Nazareth	7	·72
Totals	152½	16·08

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* With it was published the 'Itinerary of the Holy Land,' by Simon Simeon. With it was also published the tract on Leonine Verses referred to in the article on that subject.

The scale of Rennell's map is three inches to a degree of latitude; and the only remaining question is, how much must this 16·03 inches, which is a total of distances measured in the shortest lines from place to place, be increased to allow for the deviations of the roads? If we assume that the deviation was equal to that in England at the Revolution, we must * increase 16·03 in the proportion of 100 to 127, which gives 20·3581. It must be remembered that the more allowance is made for deviation, the longer is the leuca; and we think it is the least supposition which can be made, to suppose the deviation on routes in Palestine no greater than in England. Dr. Bernard states that it was the practice of the Oriental geographer Abu Rihan (Al Biruni or Birunius) to deduct one-fifth from distances measured on the roads, to obtain the true distances in a straight line. This amounts to increasing the number of miles measured on the map in the proportion of 100 to 125, and is practically accordant with the preceding rule in a question of which the data are as rough as in the present one. The testimony is valuable as referring to roads in the East, and at the period to which Bacon's account refers. The leuca is then, on these suppositions, ·1335 of an inch on Rennell's map, or ·0445 of a degree. The length of the degree in these latitudes being assumed at 363,500 feet, we deduce 3·064 statute miles as the length of a leuca, or 1·532 statute miles as the length of the old mile. If we were to reject the correction for deviation, the result would be 1·206 statute miles, which is unquestionably too small.

In 1422 Sir Gilbert de Launoy was sent by Henry V. of England, on a tour of military observation in Egypt and Syria. His account is published (from a manuscript in the Bodleian) in the 21st volume of the 'Archæologia.' He never mentions the league more than once or twice, and gives all his distances in miles. From his account of Egypt we soon found that no hypothesis would make his distances agree with modern travellers. He places the city of Cairo, for instance, three miles from its port Boolak, which distance is now called only *one* mile. [KAHIRA, in GEOG. DIV.] But on examining his distances in Palestine there appears almost a certainty that he used a smaller mile, of which two and a half (and not two) make the league of Roger Bacon. The following are all the comparisons which his work affords us the means of making:—

	Bacon. Leagues.	Lannoy. Miles.	League in Miles.
From Joppa to Aco	24	60	2·5
„ Aco to Tyre	9	25	2·78
„ Tyre to Sidon	8	20	2·5
„ Sidon to Baruth . . .	8½	25	2·94
„ Jerusalem to Joppa . .	12	30	2·5

But even Lannoy's mile must be longer than our statute mile; and it is difficult to explain the difference. One thing is certain, that Lannoy's mile in 1422 cannot be the same thing with that of William of Worcester in 1473, or that of Bacon in 1250, being shorter than either.

So far our conclusions proceed upon assumptions of the highest probability; and the result is, that from the English measurements we may infer that 100 ancient miles certainly exceed 141 statute miles, while from those in Palestine they are most likely not much less than 153 such miles. It is highly probable that the result is nearer to 153 than to 141. If we were to take a mean of both results, giving them equal weights, the mile thus obtained would be probably too small, and this result is 1·47; so that (as mentioned in LEAGUE) the ratio of 145 to 100 is the very least which is admissible, and perhaps too small even for a minimum. It seems to us that a more probable result would be obtained by taking 153 as a result of the measure in Palestine (for it is hard to believe that the correction for deviation could have been too much), and giving this number twice as much weight as 141 in forming a mean of the two. This gives 149 in place of 147; or, roughly speaking, we think it by no means improbable that 100 ancient miles were as much as 150 statute miles, and tolerably certain that they exceeded 145 such miles. At the same time there is evidence enough that very different miles were in use among writers, and also that the most ignorant confusion between ancient and modern measures frequently existed. Sir John Maundevile, for instance, says, "Aftre the auctoures of astronomye, 700 furlonges of erthe answeren to a degree of the firmament: and tho ben 87 miles and 4 furlonges. Now be that here multiplyed by 360 sithes; and than thei ben 31,500 myles, every of 8 furlonges, aftre myles of oure contree." The old astronomical authors use the stadium, which is here made to be the English furlong, a measure with which it had no connection.

There is certainly this difficulty in the way, that [LEAGUE] the ancient minimum distance between two market-towns must have been 19 modern statute miles, which seems a great distance. But it must be remembered that this appearance is a consequence of the notions derived from the modern interpretations of the courts, which make the leuca to be a statute mile; so that 7 miles has long been the legal distance. This interpretation is so preposterous that it must be thrown aside; for even if the mile of Bracton and Fleta were the mile of the *books*, and not the mile of the *people*, the leuca would be 10,000 feet, or two statute miles all but the tenth of a mile. And the reason given by Bracton certainly requires some greater distance than seven miles. For he implies [LEAGUE] that the third of a day's work should be the distance of two markets; and gives a time for buying and selling not longer in duration than that allowed for going to the market. Reading this paragraph by the modern interpretation of the courts, the time of business would be that in which a laden horse or market-cart would go three miles and a half; and if, taking into account the badness of roads in the 15th century, we allow even as much as two hours for this, then the day's work would be only six hours. According to our reading, the time of going nine miles and a half would be the time of business; or allowing three miles an hour, the day's work would be something more than nine hours. It may however be possible, and not improbable, that the mile of 5,000 feet, or that of the books, was that of the courts of judicature, which would give about 12½ statute miles as the distance in question.

We conjecture that the length of the ancient mile arose from the confusion between the mile and the leuca which is referred to by Ingulphus. [LEAGUE.] The leuca of fifteen hundred paces would, when the foot attained its permanent length, be 1·42 modern statute miles, to which the term mile being applied, we have the probable beginning of the old mile, that is, we adopt D'Anville's conclusion on different grounds. If in the meanwhile the leuca of 2000 paces came into use (as, according to Ingulphus, it did), which would be called in the books two miles (as in fact it was two miles of the *writers*), it is by no means surprising that a new leuca of two long miles should be formed from the mile of the people. This would be but a poor conjecture for the establishment of a measure; but it has great force in reference to a mile, the existence of which is separately proved. Although Ingulphus states that the word leuca was introduced as meaning a mile, yet it is more likely that the new measure should have been introduced under the old name, than the new name for the old measure: it is moreover tolerably certain that the conquerors would attempt to introduce both their measure and its name, while the people would be able to resist the latter, but not the former.

The origin of the statute mile may perhaps be explained as follows. The furlong, or quarantena, was not a part of the Roman itinerary system of measures. It grew out of the perch, or perticata, a measure originally of small lengths, as in buying or selling of land, 40 of which were made into one by the simple name of forty-long, or furlong. The great variations of the perch, in different parts of the country, induced the legislature, at a very early period, to fix it at five yards and a half. It did not harmonise with the book-system of measures, and we see [LEAGUE] that when it was introduced there, the mile was awkwardly described as seven furlongs and a half, three perches, and two palms. The legislators of Elizabeth, who were well acquainted with the stadium, seeing the mile of the books (and perhaps of the courts) making upwards of seven furlongs and a half, might very naturally restore the nominal accordance of the old and modern systems, and at the same time avoid fractional quantities, by lengthening the mile into eight furlongs.

MILITARY POSITIONS. [TACTICS.]

MILITARY PUNISHMENTS. We have little knowledge of the manner in which offences against military discipline were punished by the Greeks; but it appears that, for sedition or mutiny, the commander of an army had the power of causing the ringleaders to be seized and instantly put to death. Agamemnon, in the 'Iliad,' threatens such as may desert, that they shall die; and Alexander the Great, when a mutiny took place partly in consequence of the jealousy excited by the favour which he showed to the Persians, caused thirteen of his Macedonians to be executed without a trial. (Arrian, 'Anab.' vii. 8.) The military law of Athens prescribed the punishment of death for the crime of desertion while on service. Occasionally, however, this serious offence was only punished with imprisonment or fine; for, whatever might be the power of an Athenian commander over his soldiers in the field, it is probable that he would be very careful how he exercised it; since, at the termination of a campaign, a man who might consider himself unjustly treated could compel his officer to answer for his conduct before a tribunal of his countrymen. Among the Lacedæmonians, cowards and deserters were either put to death or publicly disgraced; offenders who did not suffer the extreme penalty were made, when at home, to wear a party-coloured dress, and were obliged to submit in silence to any insult which the meanest citizen might choose to offer. Disgrace also fell upon the soldier who, in action, had the misfortune to lose his shield.

The Romans punished crimes committed by the soldiery with great severity. For the gravest offences soldiers were beheaded or crucified; and under the Pagan emperors some, probably such as professed the Christian religion, were burnt alive or exposed to wild beasts. On the occurrence of a mutiny, every tenth, twentieth, or hundredth man was sometimes chosen by lot, but generally only the ringleaders were selected for punishment. Deserters and seditious persons were frequently, after being scourged, sold for slaves; and occasionally the offender was made to lose his right hand, or was bled nearly to death.

If a soldier absented himself from the spot assigned to him for the night-watch, or if he was found asleep at his post, he was the next day brought before the tribune, who on the fact being proved, sentenced him to suffer the bastinado. It appears from Polybius (vi. Ex. 2) that the tribune having gently touched the offender with his staff as a signal, the persons appointed to inflict the chastisement fell upon him and struck him repeatedly with sticks or stones, frequently with such violence as to cause his death: the culprit was allowed to escape by flight if able; but in this case he was never permitted to return to his country, or, if he did return, no person dared to afford him shelter or relief.

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* We take this from some rough trials, out of Ogilby's book, but we rely more on the eastern geographer presently mentioned.

Punishments of a like nature, but less severe, were inflicted upon a soldier who was guilty of theft, or of giving false testimony either in his own favour or against a comrade. For certain breaches of discipline the offender suffered a temporary deprivation of his pay, the forfeiture of his arms, or degradation from his rank. Sometimes he was sentenced to remain outside of the camp exposed to the chance of being taken by the enemy, or he was made to stand for a certain time in an unmilitary dress before the prætorium. In some cases a culprit was sentenced to perform hard labour, to exchange into a corps of inferior rank, or to be entirely dismissed from the service with disgrace. Punishment was also inflicted on a soldier for cowardice or for losing his arms. A centurion guilty of a breach of discipline was deprived of the staff (a vine branch) which he carried as an emblem of authority.

A dictator could sentence to death any offender against military regulations; and the consuls had the power of exercising summary jurisdiction in capital cases. Punishments were ordered by the legionary tribunes, and by the præfects of the allies, with the concurrence of a council.

Among the nations of modern Europe the punishments for military offences were, till lately, no less severe than they were among the Romans. Besides the infliction of a certain number of lashes with cords, soldiers convicted of theft, marauding, or any other breach of discipline which was not punishable with death, were sentenced to run the gauntelope as it was called. For the execution of this sentence the regiment was drawn up in a double line; and each man being furnished with a small stick, generally of osier (except the grenadiers, who used their belts instead of the sticks), the culprit, naked to the waist, was either marched slowly or allowed to run as fast as he could, according to circumstances, from the head to the rear extremity between the two lines, each man striking him as he passed along. In certain cases the offender was afterwards expelled from the regiment, and sometimes also from the town or district with a charge never to appear there again under pain of death. The punishment of the knout, in the Russian army, is inflicted with a leathern belt on the naked back of the offender.

Cavalry soldiers were formerly frequently punished by the *picket*, as it was called; this consisted in the man being made to hang by his hands from a beam during a certain time, a stake with its upper end made sharp being planted in the ground under him; so that, when from weariness he could no longer keep himself up, his foot was pierced by the stake: this kind of punishment has been long since abolished.

Confinement without light during a certain number of hours was, and still is, a frequent punishment for being absent without leave from parade, either on account of drunkenness or from any other cause. Formerly the pillory was a punishment awarded to offences of this nature.

Besides the punishments of death and transportation, which, for great crimes, are within the scope of military law, in the British army, breaches of discipline are visited by flagellation, temporary imprisonment, extra drills, extra guards, and the performance of fatigue duties; but punishments consisting of protracted periods of confinement to barracks accompanied with laborious employments, inflicted at the discretion of commanders of regiments, have been abolished for many years, not however before the most serious mortality in consequence had made it absolutely necessary.

While an army is in the field, breaches of discipline must be punished with promptitude and more than ordinary severity. It might be presumed that acts of treachery will seldom be committed; desertions to the enemy however do occasionally take place; but the more usual crime is that of quitting the ranks on a lawless expedition of plunder, which is generally accompanied with gross acts of outrage, violation of chastity, often murders, committed on the defenceless people of the country; and no doubt can exist that soldiers guilty of such crimes should be shot or hanged on the spot. Even when the crime is less heinous, the well-being and perhaps the safety of the army may be perilled in consequence of the resentment excited among the surrounding inhabitants; such disorders must therefore be repressed by making signal examples of the offenders. In the presence of an enemy there can scarcely be a more serious offence than intoxication; miscarriage of an enterprise, and defeat, with the loss of numbers of gallant men in an action, may be the fatal consequences of indulgence under such circumstances. Trial, and on conviction punishment, should be if possible immediate; the army may change its position or cantonments; delay takes place, and the necessary witnesses are at a distance, or in the mean time removed by the accidents of war. A long interval between the commission of a crime and its punishment diminishes the fear of the latter by opening to the culprit another chance of escape; it moreover diminishes the effect of the punishment as a warning: the impression produced by the crime wears off, and the punishment assumes, in some measure, the appearance of an act of cruelty. Employment of the accused meanwhile in any of the duties of the camp or field is a condonation of his offence that makes his subsequent punishment inhuman, and unmilitary, if not quite illegal.

The circumstances of an army in peace, and in war, or rather when in the presence of an enemy, are very different: in the former case soldiers have no opportunity to commit treason or to pillage a country; and since the generality of the men who then enter the army are such as have a fair moral character, great crimes among them are as unfrequent as they are among an equal number of men in any other condition of life: the punishments for such offences as may then be committed may therefore with propriety be of the same nature and degree as those which would be adjudged for corresponding offences by the ordinary courts of justice. Imprisonment for a time, employment in laborious tasks, but particularly a forfeiture of pay and pension, where the offender is without a family depending on him for support, might, probably, with advantage, be made the punishment for military offences.

Serious breaches of discipline are still punished with the lash; but the maximum number of lashes that may be inflicted is now these several years past reduced to fifty. But the objections to this description of punishment are of a kind not to be removed or modified by any modification in the degree of severity with which it is inflicted. It is both cruel and disgusting; it is permanently degrading, leaving on the character an indelible impression, and on the skin for life the marks of disgrace which, if discovered by any accident, cannot fail to produce a prejudice against the individual, how well soever he may have conducted himself subsequently to the infliction. It falls, moreover, with unequal effect on different persons according to the state of their health, or of their nervous systems at the time; and not unfrequently, according to the will of the person who administers or who superintends the punishment. It may be added that many of the soldiers who are drawn up to witness it, can neither avoid sympathising with the culprit nor becoming dissatisfied with a service in which they are exposed to such disgrace and suffering.

Happily the terrible scenes that used to be exhibited at the triangles in the British army have now ceased for ever. General Sir Charles Napier, in his 'Remarks on Military Law,' states that forty years before the time at which he wrote (1837), he frequently saw from 600 to 1000 lashes inflicted under sentence by merely regimental courts-martial; and in those days a man who had suffered a part of the punishment was often brought from an hospital when the wounds were barely healed, to receive the remainder. A milder code is happily substituted in these days for the preservation of military discipline. The practice of giving rewards for good behaviour, now so happily introduced in the military service, and the instruction obtained at the regimental schools, will in time, it is hoped, operate a beneficial change in the characters of such men as have not, from nature or from early education, a just sense of moral rectitude and of the obligations all are under of punctually and faithfully discharging the duties they owe to their country. The existing code is particularly described in the article Mutiny Act, *post.* (See Sir C. Napier's *Remarks on Military Law.*)

MILITARY TENURES. [Feudal System.]

MILITIA. The body of soldiers raised for the defence of a nation may be called the militia of that nation; but in Great Britain and Ireland the term is applied particularly to those men who are either chosen by ballot or volunteer to serve for a certain number of years within the limits of these realms. The regulations of the militia service differ widely from those of the conscription on the Continent; since under the latter the troops become members of the regular army, and may be marched beyond the frontiers of the state; whereas the militia is enrolled only for home service, and may be said to constitute a domestic guard. Nothing corresponding to modern militia can be said to have existed among the ancients. In the Grecian states every citizen was a soldier; and every person, between certain ages, in the city and in the provinces, was obliged to serve in the Roman armies wherever they might be employed.

The military force in this country in the time of the Saxons was formed by a species of militia, and every five hydes of land were charged with the equipment of a man for the service. The ceorles, or peasants, were enrolled in bodies and placed under the command of the Ealdermen or chiefs, who were elected by the people in the folkmotes.

After the Norman conquest of the country the proprietors of land were compelled, by providing men and arms in proportion to their estates, to contribute to the defence of the realm in the event of a threatened invasion. The troops were raised under the authority of *commissions of array*, which were issued by the crown; and the command was sometimes vested in the persons to whom the commissions were granted; though frequently the high constables, or the sheriffs of the counties, commanded in their own districts. This militia seems, at first to have been liable to be marched to any part of the kingdom at pleasure, but in the reign of Edward III. it was decreed by a statute that no man thus raised should be sent out of his county, except in times of public danger. From the reign of Philip and Mary the lords-lieutenant have had the charge, under the sovereign, of raising the militia in their respective counties.

Charles I. having, by the 'Petition of Right,' been deprived of the power of maintaining a disposable body of troops in the country, found himself, in 1641, unable to suppress the rebellion then raging in Ireland; and was in consequence induced to commit the charge of restoring peace to the care of the parliament. The latter immediately availed itself of the circumstance to get into its own hands all the military force of the nation; and in the following year the two houses passed a bill in which it was decreed that the power over the militia, and also the command of all forts, castles, and garrisons, should be vested in certain commissioners in whom they could confide. The king having refused his assent to the bill, the parliament made a declaration that it was necessary to put the nation in a posture of defence, and immediately issued orders to muster the militia; on the other hand, the king issued commissions of array for a like purpose to some of the nobility, and thus commenced that war which desolated the country for several years.

When Charles II. ascended the throne, the national militia was re-established on its former footing, and the chief command was vested in the king. The lords-lieutenants of counties were immediately subordinate to the sovereign, and granted commissions (subject, however, to the king's approbation) to the field and regimental officers who commanded under them. New regulations respecting the amount of property which rendered persons liable to the charge of providing men and arms were then established; and at that time no one who had less than 200*l.* yearly income or less than 2400*l.* in goods or money could be compelled to furnish a foot soldier; nor could one who did not possess 500*l.* per annum, or an estate worth 6000*l.* be made to provide a man for the cavalry. Persons having less property were required, according to their means, to contribute towards finding a foot or a horse soldier. The militia was then mustered and trained, by regiments, once a year and during four days; but the men were mustered and trained, by companies, four times in the year, and during two days each time. At the periods of mustering, every man was obliged to provide himself with his own ammunition.

These regulations, being found to be expensive, at length ceased to be observed, and the trainings of the militia were discontinued in every part of the realm except the city of London. In 1756, under an apprehension that the country was about to be invaded by a French army, considerable bodies of Hanoverian and Hessian troops were brought over for its defence: the spirit of the nation revolted however at the disgrace of being indebted to foreign mercenaries for protection; and these troops being sent back to the Continent, a national militia was again raised and organised under the sanction of an act of parliament in the 30th year of George II. The measure was generally popular, though it did not meet with universal approbation; and there were many persons who maintained the opinion that, for want of military knowledge and habits, this species of force could not be relied on in the event of its being called into active service. Experience has however shown that such an opinion is quite destitute of foundation; and it was soon afterwards admitted that, when well disciplined, these constitutional battalions rivalled those of the regular troops in the performance of all military evolutions. It may be observed here, that the greater part of the 16,000 British troops who gained the battle of Talavera were men drafted from the militia regiments at home; and so recently had they joined the army in Spain, that in the action many of them bore on their accoutrements the numbers of their former corps. (Napier, vol. ii.)

The militia laws were repealed in the 2nd year of George III., when a new act regulating the service of this force was passed; and in the 26th George III. all the previously existing statutes relating to the force were formed into one law. New regulations however were made by acts passed in the 42nd, 49th, 51st, and 52nd years of the same reign, and these with the acts passed in the 15th, 16th, 17th, 18th, and 19th Vict., contain the law applicable to the militia at present. The militia of the kingdom is now placed under the lords-lieutenants of counties, appointed by the sovereign, who have power to call them out and train them annually, and is subject to the provisions of the mutiny act, or articles of war. The sovereign until lately was only empowered to employ it in any part of the United Kingdom, but not out of it. In 1813, an act was passed allowing the militia, when volunteering, to be formed into provisional regiments to co-operate with the regulars; and in 1855, by special act, her Majesty was enabled "to accept the services of the militia out of the United Kingdom for the vigorous prosecution of the war." The militia of Great Britain may serve in Ireland, and that of Ireland in Great Britain: the period of service for each, out of the island to which it belongs, being at most two years. When called into active service the officers rank with those of an equal grade in the regular army, but as the juniors of each grade, and they may receive promotion for meritorious services during a rebellion or an invasion; but no officer of militia can serve on a court-martial at the trial of an officer or soldier of the regular troops.

All persons not labouring under bodily infirmity and not specially excepted, are liable to be chosen for private militia men, by ballot, in each parish, and are compelled under a penalty of 10*l.* to serve either personally or by substitute. Volunteers paid, by consent of the inhabitants, by parish assessments, may however be substituted for balloted men. The persons excepted are—peers of the realm; commissioned and non-commissioned officers and privates serving in the regular forces; half-pay officers of the navy, army, and marines, and commissioned officers who have served four years in the militia; members of corps of yeomanry and volunteers, and privates serving in the local militia; seamen and persons doing duty in the royal docks, at the gun-wharfs, and powder magazines; also persons employed under the direction of the Board of Ordnance; resident members of the two universities; clergymen of the Established church; also Protestant dissenting preachers, provided they take the oaths of allegiance and supremacy, and exercise no other occupation, or only that of schoolmaster; constables or other peace-officers; articled clerks; apprentices; free watermen on the Thames; poor men having more than three legitimate children, and persons above 45 years of age. To alleviate the distress of a poor man, when drawn for the militia, and who has provided a substitute, the churchwardens of the parish are bound to return to him a sum not exceeding 5*l.*, or half the current price of a substitute. No one having served personally, or by substitute, during three years in the militia, can be obliged to serve again till it comes to his turn by rotation; but if a man has served as a substitute for another, this does not exonerate him from serving again if chosen by the ballot.

The militia is trained and exercised by battalions or regiments twice in a year, and during fourteen days each time, or once in a year for twenty-eight days, at the discretion of the lords-lieutenants or their deputies.

The supplementary militia is an additional body of men which was first raised in 1793, for the defence of the country at that juncture. It is still continued to be raised when the necessities of the state require it, and it is subject to the same regulations as the ordinary militia. The local militia was a body raised in 1809, for the purpose of replacing, in certain districts, the corps of volunteers. By the 52nd George III., this force may be marched to any part of Great Britain in the event of a rebellion or an invasion, and it may be kept embodied till six months after the former is terminated or the latter repelled. Persons enrolled in the local militia cannot be compelled to serve in the regular militia till one year after their period of service in the former has expired.

The whole amount of the regular militia forces in Great Britain alone in 1806 exceeded 200,000 men, and with the local militia and volunteers the force which might have been assembled in arms amounted to more than twice that number, or nearly 500,000 men.

When the militia were called out during the late war with Russia the numbers, according to a parliamentary return of the 14th March 1855, were—in England, 44,198; Scotland, 4461; Ireland, 13,095 total, 61,754. These numbers fluctuated very much, owing to the numbers who volunteered into the line.

In France a militia was first raised from the provinces during the reign of Louis XIV.; but the several corps were disbanded after the peace of Ryswick. In 1726 was organised a force of the like kind, consisting of men chosen by lot from the towns and villages, and held in readiness to be assembled when required; and in 1778 these provincial troops were formed into 106 battalions. Since the Revolution of 1792 the National Guard may be said to constitute the militia of France.

In the United States of America, by an Act passed in 1792, the principal provisions of which are still in force, all able-bodied white male citizens between the ages of 18 and 45, with certain exceptions are enrolled in the militia; and when drafts are to be made for active service, the individuals are selected by ballot, as in this country. The persons excepted are the executive, judicial, and representative officers of the union, those who are employed in the post-office department, &c.; and, in some of the states, persons are exempted who have scruples of conscience against bearing arms. The president has the power of calling out the militia of the states; and, when on active service, it is subject to the same rules and articles of war as the regular troops, but courts-martial for the trial of militia offenders are composed of militia officers only.

A national militia, when properly constituted, is an institution of the highest utility to a state, the men being engaged in military occupations only so long as may be necessary for becoming qualified to serve as soldiers when called upon to take the field, and being at all other times employed in labours subservient to the practice of the useful arts. They thus possess the united characters of defenders of their country and of contributors to its prosperity, while they remain connected in social union with their fellow-citizens, and are interested, like them, in the support of the laws and in the preservation of good government. It is in some respects otherwise with the soldiers of a regular army, devoted exclusively to the profession of arms, and, though their services are indispensable in the prosecution of foreign wars, have few feelings in common with the civil portion of the community; and who, except in a nation like Great Britain, where the military power is duly subordinated to the civil magistrate, might, under the influence of an ambitious chief, become dangerous to the liberty of their country. The system of embodying militia regiments for long periods, which has prevailed since the Crimean war, cannot be defended, except on the ground of urgent necessity, as they can then no longer be formed of the same class of men; while, from the constant volunteering into the line, the discipline is impaired.

MILK, *Analysis, and Uses of.*

100 Parts of the Milk of the	Cream.	Butter or Fatty Matter.	Caseum.	Sugar of Milk.	Total Butter, Caseum, and Sugar of Milk.
Ewe (Stiprian Luiscius, and Bondt)	11·5	5·8	15·3	4·2	25·3
Goat (ditto) . .	7·5	4·56	9·12	4·38	18·06
Goat (Payen) . .	not stated	4·08	4·52 including insoluble salts.	5·86 including insoluble salts.	14·46
Cow (Stiprian Luiscius, and Bondt)	4·6	2·68	8·95	3·60	15·23
Cow (Berzelius) .	not stated	4·5	6·10	3·5	14·10
Woman (Payen) 1st case .	not stated	5·16	0·180	7·62	12·96
Woman (Payen) 2nd case .	not stated	5·2	0·250	7·930	13·38
Woman (Payen) 3rd case .	not stated	5·18	0·240	7·86	13·28
Ass (Stiprian Luiscius, and Bondt)	2·9	..	2·3	4·5	6·8
Mare (ditto) . .	0·8	..	1·62	8·75 (only 3·7 according to Young.)	10·39

From this analysis it would appear that milk is a compound fluid, chiefly consisting of oleaginous and albuminous materials, with different salts.

According to Dr. Prout, "albuminous and oleaginous principles may be considered already fitted for the purposes of the animal economy, without undergoing any essential change in their composition." And thus, by the action of the organs of the parent, the food is brought into a state very favourable for its assimilation in the body of the young, without taxing severely the digestive organs of the latter. The salts present in the milk serve also important uses, especially the phosphate of lime by consolidating the bones, which, at the time of birth, are soft and cartilaginous. The period when lactation in the human offspring should cease must vary with the vigour and progress of development of the infant; but in general nine months is the proper time for suckling, and its continuance beyond that period is injurious both to parent and child.

The milk of cows or other animals is extensively used as the food even of adults, and, though insufficient alone, is a most valuable ingredient of diet. It is often enjoined as the food of invalids, especially of persons who have a tendency to consumption.

Milk is also used as an antidote in cases of poisoning by some metallic salts, such as corrosive sublimate, perchloride of tin, sulphate of copper, &c.

Though cheese is in general difficult of digestion, fresh-pressed curd is often found to suit the stomach of persons affected with disease of that organ. (See Abercrombie, 'On Diseases of the Stomach.')

Milk may be brought to a dry state, and powdered, in which condition it keeps for a length of time; and by dissolving it in tepid water an artificial milk may be formed, capable of being used at sea, particularly for children during long voyages. [Milk, and Food, in Nat. Hist. Div.]

Milk, in its commercial relations, has been affected in a remarkable degree by the opening of railways. Under the old system, London and other great towns had their entire supply of milk from dairies in and near the towns themselves. [Dairy.] The adulteration, so much complained of, was due to the small dealers; the milk was sent from the large establishments in a pure state. Attempts were more than once made to insure the genuineness of the milk sold by retailers, by establishing joint-stock companies, and sending out the milk in locked cans; but the companies failed as commercial speculations. This system, though not superseded, is greatly lessened by the facilities of railway conveyance. Farmers and dairymen within fifty miles of London can send up milk at an average cost of about three farthings per gallon for freight, and sell it to the smaller dealers. New York and other cities of America, are supplied in a similar way.

Much useful progress has been made in so treating milk that it will keep good for a considerable length of time, and thus be available at times and places where cows cannot be kept. We will briefly describe some of the processes adopted. Moore's essence of milk is prepared by placing the milk in long shallow copper pans, heating it by steam to 110° Fahr., adding a little sugar, and stirring for four hours; the milk loses three-fourths of its bulk by evaporation; and the rest, as a very thick cream, is put into small tin cases, soldered down, steeped in boiling water for a time, and taken out to cool. This milk will keep good for a long period. Blatchford's solidified milk is thus prepared. About 112 lbs. of milk are mixed with 28 lbs. of white sugar, and a teaspoon-ful of bicarbonate of soda; the liquid mixture is exposed for three hours in an enamelled iron pan, to the heat of steam; while it is at the same time being constantly stirred, and a blast of cool air blown upon its surface. This is continued until the milk is converted into a kind of creamy powder, which is cooled, weighed into parcels of 1 lb. each, and pressed by heavy weights into brick-shaped pieces; these bricks are grated into powder when the milk is to be used. Grimwade's desiccated milk has a little sugar and alkali mixed with it; it is heated and stirred over a hot water boiler until as thick as dough; then dried into hard cakes, crushed beneath granite rollers, and bottled. This milk was used by Miss Florence Nightingale in the hospitals at Balaklava and Scutari. Fadeuille's desiccated milk is prepared nearly in the same way as Grimwade's; and a suit for infringement of patent was brought by one inventor against the other in 1859. At the Aberdeen Meeting of the British Association, in 1859, the Abbé Moigno gave a brief description of four kinds of milk preserved by methods adopted in France. Villeneuve's is rendered solid by the addition of solid substances; but it is no longer milk proper. Signac's is a kind of syrup of milk and sugar. Maber's is prepared by putting the milk into a vessel, excluding the air, exposing it to a steam atmosphere of 100° centigrade, and sealing it up in bottles; Moigno found this kind of milk perfectly good after five and a-half years keeping. The Abbé brought to Aberdeen some milk which had been prepared by De Pierre's process, the details of which were not fully made public. This milk, unlike others in a prepared state, is liquid. Heat is applied in some peculiar way, so as to remove a sort of diastase or animal ferment which exists in minute quantity in milk, and which is the real cause of its speedy decomposition. The milk brought by Moigno from France to Aberdeen had undergone a good deal of shaking during its travels; but it was pronounced by Professor Christison to be perfectly sweet and fresh.

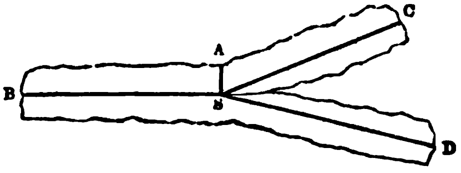
There are other processes for preserving milk, mostly in a dry or a pasty state; but the above will sufficiently illustrate them all. Some of the preserved milks are over-sweetened with sugar, while others afford proof that the cheese-making stage has just been touched; and it is evident that the process requires to be conducted with great precision.

MILKY WAY. It is desirable, in describing astronomical objects, to keep as close as possible to the words of those who are accustomed to the sight and description of such things. Two passages in Sir John Herschel's 'Astronomy' will describe the Milky Way, and the theory of it, by Sir William Herschel, with excellent brevity and distinctness.

"There are not wanting *natural* districts in the heavens, which offer great peculiarities of character, and strike every observer: such is the Milky Way, that great luminous band which stretches, every evening, all across the sky, from horizon to horizon, and which, when traced with diligence, and mapped down, is found to form a zone, completely encircling the whole sphere, almost in a great circle, which is neither an *hour* circle nor coincident with any other of our astronomical *grammata*. It is divided in one part of its course, sending off a kind of branch, which unites again with the main body after remaining distinct for about 150°. This remarkable belt has maintained, from the earliest ages, the same relative situation among the stars; and when examined through powerful telescopes, is found (wonderful to relate!) *to consist entirely of stars scattered by millions*, like glittering dust on the black ground of the general heavens.

"If the comparison of the apparent magnitudes of the stars with their numbers leads to no general conclusion, it is otherwise when we view them in connection with their local distribution over the heavens. If indeed we confine ourselves to the three or four brightest classes, we shall find them distributed with tolerable impartiality over the sphere; but if we take in the whole amount visible to the naked eye, we shall perceive a great and rapid increase of number as we approach the borders of the Milky Way. And when we come to telescopic magnitudes," or stars of so small a magnitude as to be invisible except through a telescope, "we find them crowded, beyond imagination, along the extent of that circle, and of the branch which it sends off from it; so that in fact its whole light is composed of nothing but stars, whose average magnitude may be stated at about the tenth or eleventh.

"These phenomena agree with the supposition that the stars of our firmament, instead of being scattered in all directions indefinitely through space, form a stratum, of which the thickness is small, in comparison with its length and breadth; and in which the earth occupies a place somewhere about the middle of its thickness, and near the point where it subdivides into two principal laminæ, inclined at a small angle to each other. For it is certain that to an eye so situated, the apparent density of the stars, supposing them pretty equally scattered through the space they occupy, would be least in a direction of the visual ray (as S A) perpendicular to the lamina, and greatest in that of its breadth,



as S B, S C, S D; increasing rapidly in passing from one to the other direction, just as we see a slight haze in the atmosphere thickening into a decided fog-bank near the horizon, by the rapid increase of the mere length of the visual ray. Accordingly, such is the view of the construction of the starry firmament taken by Sir William Herschel, whose powerful telescopes have effected a complete analysis of this wonderful zone, and demonstrated the fact of its consisting entirely of stars. So crowded are they in some parts of it, that by counting the stars in a single field of his telescope, he was led to conclude that 50,000 had passed under his review in a zone two degrees in breadth, during a single hour's observation. The immense distance at which the remoter regions must be situated, will sufficiently account for the vast predominance of small magnitudes which are observed in it." [Herschel, Sir Wm., and Herschel, Sir John, in Biog. Div.; Nebulæ; and Stars.] But to the above it must be added, that the fifty thousand stars thus mentioned as contained in a zone of 15° by 2° include only those which could be steadily seen and distinctly numbered; besides which, twice as many more were suspected, of which only occasional glimpses could be got for want of sufficient light.

The Milky Way may be described in general terms as extending three or four degrees on each side of a great circle inclined at an angle of about 60° to the ecliptic, which it cuts in the northern hemisphere between the horns of Taurus and the feet of Gemini, and in the southern hemisphere between Sagittarius and Scorpio. Beginning with the part nearest to the North Pole, it nearly covers Cassiopeia and Perseus, and then, becoming thinner, passes through Auriga, between Taurus and Gemini, and near the back of Canis Major through Argo. It then narrows considerably, and passing under the hind feet of Centaurus, widens again near Ara. A little above the last constellation, and before it again meets the ecliptic, it divides into the two streams above mentioned, which contain between them a long thin strip passing through part of Scorpio, Serpens, Aquila, Vulpecula, and Cygnus. In Cygnus the streams reunite, but immediately separate again, finally reuniting higher up in the same constellation, from whence the main stream reaches Cassiopeia, &c.

Sir John Herschel, in his 'Results of Astronomical Observations made during the years 1834-5-6-7-8, at the Cape of Good Hope,' 4to., 1847, has some valuable remarks on the general appearance and telescopic constitution of the Milky Way in the southern hemisphere; and has also given an accurate delineation of that portion of it which extends from the constellation Antinoos through Centaurus to Monoceros.

The Milky Way was called by the Greeks *γαλαξίας*, (whence our word *Galaxy*), or *κύκλος γαλακτικός*, and by the Romans *Orbis lacteus*. The mythology of the former people on the subject is as edifying as usual: Hyginus fixes on Eratosthènes the most common story, namely, that the Galaxy arose from the milk of Juno, who pushed Hercules away from her breast (where he had been placed by Jupiter) on learning that he was the son of Maia. Nor does the above accurate writer forget to mention that others held the appearance to have arisen from young master Hercules having been a greedy child, and having filled his mouth too full. Others thought that the whole was not milk, but ears of corn which Isis dropped in her flight from Typhon. Another fable, mentioned by Plato, makes the Milky Way to be a broad causeway through the heavens for gods and heroes to walk upon; another, that it is the part of the heaven which was singed when the horses of the sun ran away with Phaeton. These stories are a proper prelude to the speculations of the philosophers which followed. Some of the Pythagoreans are reported to have supposed the Milky Way to be an old and disused path of the sun, out of which, some said, he was frightened by the banquet of Thyestes; others, a reflection from the sun. Anaxagoras is said to have thought it was the shadow of the earth: Aristotle supposed it to be sublunary, and to consist of exhalations of the same matter as comets. Posidonius took it for a band of fire; Theophrastus for a solid and luminous band, joining together the two hemispheres; while Diodorus thought it was celestial fire shining through the clefts of the solid heavens. Democritus hit the true explanation, namely, that it is a congeries of little stars too small to be separately seen—an opinion which both Plutarch ('De Placit. Philos.,' l. iii., c. 1) and Manilius mention. Shortly after the invention of the telescope, Galileo announced that he had resolved the whole of the Milky Way into stars. "Est enim *Galaxia* nihil aliud quam *innumerarum stellarum coacervatim consitarum congeries:* in quamcunque enim regionem illius perspicillum dirigas, statim stellarum ingens frequentia sese in conspectum profert quarum complures satis magnæ et valde conspicuæ videntur, sed exiguarum multitudo prorsus inexplorabilis est." ('Nuncius Sidereus.') It is however not easy to suppose that Galileo's resolution of the Milky Way was complete; and we may here see how necessary is attention to minute description. When Sir J. Herschel, in the paragraph cited above, states the stars to appear "like glittering dust *on the black ground of the general heavens*," we know that, if the observer can be depended upon, he has completely resolved the continuous light in question: but if he only says, with Galileo, that he detected innumerable stars, we are only sure that he has distinguished the nearer stars, and may suppose that the more distant ones still formed a Milky Way behind them. That this must have been the case with Galileo (whose telescopes would never distinctly show Saturn's ring) may be confidently asserted. It must also be remembered that Galileo had completely resolved several nebulæ, and might easily have completed his assertion as to the Milky Way from analogy. Kepler ('Dioptr. Pref.') describes this resolution in a way which will be some guide as to its character: "Nebulosa stella ostendit, ut in Via Lacteâ, duas, tres, vel quatuor clarissimas stellas in arctissimo spatio collocatas;" that is, two, three, or four stars were seen in the smallest space: this may very well correspond to Sir W. Herschel's estimate of 50,000 in the zone above mentioned, without the necessity of supposing that those stars were seen, which the forty-foot reflector would only show by glimpses. Sir W. Herschel counted seventy-nine stars, on the average, in a field of fifteen minutes in diameter, showing about as much of the heavens as is covered by one-fourth part of the moon. If, which may be suspected, the "arctissimum spatium" of Kepler meant the field of his telescope, the resolution thus obtained would not quite justify the conclusion, except as a probable deduction; the real and necessary inference would only have been, that stars invisible to the naked eye exist in every part of the Milky Way in considerable numbers.

MILL, MILLWORK. [Coupling; Gearing; Rollers; Shafts; Wheels; Windmill; Wind-sails.]

MILLE'NNIUM, a Latin word meaning a period of a thousand years, is applied by ecclesiastical writers to the period during which it is predicted in Scripture that the Church will be in a state of extraordinary prosperity, and which is to be preceded by the overthrow of her enemies, accompanied at its commencement by the first resurrection, or the resurrection of the saints, and followed by the destruction of Gog and Magog, and the general judgment. (Rev. xx.)

Respecting the state of the Church during the Millennium two opinions are held, both of which can be traced up nearly to the earliest ages of Christianity. The one is that Christ will reign in person upon the earth at Jerusalem, that the saints will reign with him and enjoy corporeal pleasures, and that the Jews will be restored to Palestine and exalted to the first rank among the nations of the world. This doctrine was held by Irenæus and others of the earlier fathers, not merely as their own opinion, but as the faith of the Church received from the Apostles. These tenets were also held by Irenæus in the 3rd century, and by Lactantius in the 4th, who expected the Millennium to commence very soon after the time at which he lived. On the other hand it was held by Origen, Jerome, and other fathers, who warmly opposed the doctrines just mentioned, that the passages of scripture on which they are founded must be taken in an allegorical sense, and that the Millennium will only be distinguished by the universal diffusion of pure Christianity in the world, and a consequent decrease of physical and moral evil: though Nepos, an Egyptian bishop, wrote a book against the allegorists, as he contemptuously styled the adversaries of the Millennium. The opinions of Origen, however, have been adopted as the belief of the orthodox Church, and have been almost universally received in modern times. The followers of the late Rev. Edward Irving, and some other small sects, as well as many individuals among other bodies of Christians, still hold the doctrine of the personal reign of Christ on earth. Such persons are commonly called Millennarians, the name applied in the early ages of the Church, together with the corresponding Greek word Chiliasts, to those who held these opinions. (Lardner's 'Credibility;' Mosheim, 'Eccl. Hist.,' cent. iii. and iv.)

MILLET. The stalk of all the species of millet resembles a jointed reed, having at every joint a long broad leaf, which embraces the stalk with its base. It is an annual plant, growing quickly, yielding an abundance of small grains, which are set round a compact spike at the top of the stalk. The stalk itself is filled with a saccharine juice.

Millet thrives best in a light sandy soil, and if sufficient space is allowed between the plants to weed and hoe them during their early growth, they will afterwards overtop and smother all weeds, and yield an abundant return with little labour and without much manure. The seeds, however, require a climate warmer and drier than that of England to ripen properly. Millet is cultivated largely in the southern parts of Europe.

In the East, millet is used as food for men; but in Europe, though it is sometimes made into loaves and cakes, and frequently into puddings, it is mostly used for feeding poultry and domestic animals. The leaves and panicles are given, both green and dried, as fodder to cattle.

Millet has been described by botanists under the generic terms *Holcus* and *Sorghum*. The most general species, the common Indian millet, known in Nubia by the name of *Durra*, is described under Sorghum, in Nat. Hist. Div.

Sorghum saccharatum has latterly been introduced for the large quantity of sweet fodder which, when it is ripe, its straw and leaf afford for stock.

MILLION. [Mensuration.]

MIME (from the Greek *mimus* (*μῖμος*), an imitator), a dramatic performance of irregular form among the Greeks, in which occurrences of real life were clothed in a poetical dress. It usually consisted of a single scene, mostly comic, sometimes with such dialogue added as the excitement of the moment prompted. Mimes appear to have been common entertainments at feasts. Sometimes they were acted on the stage. Sophron of Syracuse (born about B.C. 420), who wrote in the vulgar dialect of the Doric Greek of Sicily, is considered the inventor of this species of composition. His mimes were in rhythmical prose, and were highly esteemed by Plato, who is said to have carried to Athens the taste for this species of composition. With the exception of a few fragments, and the names of some of his mimi, the works of Sophron are lost. The fragments of Sophron are collected in the 'Museum

Criticum,' No. VII. His son Xenarchus, who lived under Dionysius during the Rhegian war, B.C. 393, also wrote mimes. We have specimens of a mime in the fifteenth idyll of Theocritus. Philistion of Nicæa, another writer of mimes, was contemporary with the latter years of Socrates. Suidas (Φιλιστίων) calls his mimes *biologic*, or "pictures of life."

Among the Romans, mimes seem to have been nothing but irregular harlequinades, probably the lineal ancestors of our "Punch." In the time of Augustus, Bathyllus and Pylades divided the taste of the Roman capital as actors of mimi. Among the mimographers of Rome we find Mattius, Laberius, and Publius the Syrian, the second of whom died B.C. 43, when the third was in the height of his popularity. Laberius acted as well as composed mimes. The Roman mimes were written in verse, but were often delivered extempore, and the manners represented had much local truth. The actors in such pieces had also the names of *mimes*, distinguishing them from the pantomimists, who confined their representations entirely to action. In the reigns of the earlier emperors we meet with other mimographers of celebrity, but none came up to the reputation of Laberius and Publius.

(Ziegler, *De Mimis Romanorum*, Göttingen, 1789, quoted in 'Conversations Lexikon:' Schlegel, *Dramatische Verlesungen*, lecture viii.)

MIMOTANNIC ACID, *Cachoutannic Acid* ($C_{36}H_{18}O_{16}$). The tannic acid produced from catechu possesses some properties different from that of the tannic acid from oak bark, and Berzelius proposed to call the one mimotannic acid, from *Mimosa*, and the other quercitannic acid, from *Quercus*, the name of the oak.

MINARET (from the Arabic *menarah*, a lantern), in Saracenic and Eastern architecture, a very slender and lofty turret, having one or more projecting balconies around it, which divide it externally into two or more stories. They are used in Mohammedan countries for the purpose of calling the people to prayers, and therefore serve the purpose of belfries. They are, however, generally more numerous than such purpose actually demands, there being one at each angle of the building, and sometimes a greater number, and hence they become highly characteristic features, as well on account of their frequency as their tall, graceful, column-like shape, which causes them to contrast so picturesquely with the cupolas that crown the edifice, and together with which they serve to produce a pleasing and varied architectural outline. The resemblance to the column form is frequently greatly increased by the uppermost gallery being corbelled and ornamented for a short distance downwards, so as to assume the shape and mass of a capital, above which the structure is usually made to terminate in a small polygonal alcove, with open arches on its sides, and crowned by an ogive or bulbous dome. Many of the Turkish minarets are alike elegant in general form, and in their ornamentation. In some of those in India (as in the mosque at Ahmedabad) the carving is almost profuse in its splendour, but the outline is much less happy than the Saracenic examples.

MINERAL ALKALI. [SODIUM; SODA.]

MINERAL CHAMELEON. [MANGANESE.]

MINERAL PURPLE. [COLOURING MATTERS.]

MINERAL WATERS. Mineral waters, though generally characterised by possessing some principle different from what is found in common water, or some of the ordinary principles in unusual proportion, yet among these are reckoned certain springs which have no claim to repute beyond what is due to their extreme purity, such as Malvern and Holywell; or to having a higher temperature throughout the year, than the mean of the latitude where they are situated. These last are classed among the *thermal* springs, which are properly divided into two sections, the *mineralised hot* springs and the *unmineralised*, among which are some only tepid, such as Matlock, where some springs are 66°, the lowest of the class in Britain, and others cold, presenting this peculiarity, that the tepid springs rise from fifteen to thirty yards above the level of the river Derwent, whilst those which rise either above or below this range are cold.

For practical purposes mineral-waters may be classed under four heads, each susceptible of secondary heads, according as they are hot or cold, or have other peculiarities, namely: saline, alkaline, chalybeate, and sulphureous. It will not be possible to mention more than a few of the most important of each.

Saline aperient springs: of these some are hot, others cold. The chief are Carlsbad, Marienbad, Eger or Franzensbad, Kissingen, Wiesbaden, Baden-Baden, Seidlitz, and Saidschutz, with Pullna, in Germany; Cheltenham, Leamington, and Harrogate in England; Dunblane, Pitcaithly, and others in Scotland.

Alkaline waters, owing their properties to different saline principles, are found at Carlsbad, Marienbad, Kissingen, Pullna, Saidschutz, Ems, Töplitz, and Wiesbaden, in Germany; Vichy and Mont d'Or, in France; Harrogate, Scarborough, and other Yorkshire springs, Cheltenham, Leamington, Bath, and elsewhere, in England.

Chalybeate waters: with these acidulous waters are often reckoned, as the iron is often associated with much free carbonic acid gas. Some of the chief are Spa, Pyrmont, Schwalbach, Marienbad, Aix-la-Chapelle, and Seltzer in Germany; Tonbridge, Harrogate, and Brighton in England, and Peterhead, in Scotland.

Sulphureous waters: Aix-la-Chapelle, in Rhine Prussia, Bareges, and other Pyrenean springs, are hot; Harrogate, Askern, and others in Yorkshire, cold; Moffat and Strathpeffer in Scotland, also cold Ioduretted and other waters. Many springs have of late been found to contain a notable quantity of iodine or bromine, others contain both: Creuznach, in Germany, contains both, but most iodine; Llandrindod and Bualt in Radnorshire, the springs issuing from the lias at Leamington, Gloucester, Tewkesbury, and Cheltenham, contain iodine; bromine, but not iodine, exists in small quantity, in the saline aperient waters near London, such as Epsom, also in the springs from the coal-formation of Ashby-de-la-Zouch, Newcastle-on-Tyne, and Kingswood, and Bonnington near Edinburgh: Woodhall, near Ashby-de-la-Zouch, contains most iodine of any British springs yet investigated.

Organic matters, termed *Baregine*, *glairine*, *zoogene*, &c., have been found in many springs. Of these an account may be found in Dr. Lankester's 'Askern and its Mineral Springs,' p. 103.

It is impossible to give directions here for the selection of one kind of mineral water in preference to another. A decision on this point can only be made by a competent medical attendant. It may be permitted to say a few words on calcareous springs, by which is meant those waters in which some of the salts of lime predominate. These are generally hard. While flowing under ground the lime is often in the state of a soluble bicarbonate, but on reaching the external atmosphere, one portion of the carbonic acid escapes, and some of the carbonate of lime is precipitated. Hence these waters exert a petrifying effect on substances thrown into the springs or receiving wells. This is also the reason why such waters are best used on the spots whence they emerge, and ill bear transportation. Such waters should never be received in leaden cisterns or transmitted through leaden pipes. The chief mineral waters in England which belong to this group are Bath, Bristol, and Buxton. They are noted for their beneficial effects in those diseases which are connected with the presence or generation of an unhealthy acid in the stomach, such as gout, rheumatism, and some cutaneous diseases, in which the power of the water taken internally is often assisted by the use of the same water externally as baths. The change of mode of life generally adopted at watering places, the relaxation from hurtful over-exertion of mind and body, conduce to promote the health of the visitors to these places of resort.

MINERVA. [ATHENE.]

MINES. Mines are properly openings in the ground from which any thing is dug. Until an opening is made, the name is not properly applied, though the term is now generally used to signify coal, lead, iron, and so forth, before an opening is made for digging them out.

Mines belong to the tenant in fee-simple of the land, with the exception of gold and silver mines, which belong to the king by his prerogative, but by 1 W. & M. c. 30, a mine of copper or tin is not to be considered a royal mine, though silver be extracted from the ore. The owner of land in fee-simple is the owner of everything which lies in a perpendicular direction under the surface to any depth. A tenant for life, unless his estate is without impeachment of waste, cannot dig earth, lime, clay, or stone, except for the repair of buildings or the manuring of the land. In fact, the general principle is, that the land, which term comprehends everything in it or that is permanently attached to it, cannot be taken away by any other person than the tenant in fee-simple or a tenant in tail. Accordingly a tenant for life cannot open a new mine, but he may work mines which are already open, and he may open new shafts for working veins of coals which have been already worked. A tenant in tail has an estate of inheritance, and incident to it the power of committing waste, as by cutting down timber or opening mines.

If a man who has an estate in fee leases the land with the mines upon it, the lessee is thereby empowered to dig for the minerals; and if he leases lands on which mines are already open, the lessee may work them.

The freehold of all copyhold lands is vested in the lord, and it is a legal consequence that he has the freehold of the mines. In some cases a copyholder of inheritance has by the custom of the manor a right to the timber, and the lord has no right to dig mines, unless there be a custom which gives him the right.

If a man works mines under his own land, and follows the ore or other substance under his neighbour's land, he is a trespasser.

The act 7 & 8 Geo. IV. c. 30, § 6, 7, enacts certain punishments for malicious injuries done to mines. [MALICIOUS INJURIES.]

MINES, MILITARY, are excavations made in the rampart of a fortress, or underground, in order to contain gunpowder, which, being exploded, the rampart may be breached, or any works of the enemy, above or near the mine, may be destroyed.

The term *offensive* is applied to the mines which are formed by the besiegers of a fortified place; those which are formed by the garrison are called *defensive mines*, or counter-mines, this term having been given to the mines executed by the besieged, as they were the latest introduced in warfare. The cavity in which the powder is deposited is called the *chamber*; and the excavated approach to the latter is called the *gallery*, if the dimensions are above 3 feet by 4 feet; if smaller than this, *a branch*. These are termed ascending or descending, according to their direction, though if they are vertical they are termed *shafts*.

Two kinds of mines were anciently employed in the attack of fortresses. One of them was merely a subterranean passage carried under the walls from the exterior ground; and being suddenly opened within the town, the assailants were enabled to enter the latter by surprise. The other kind was executed in a similar manner, and was intended to lay the rampart of the place in ruins; for this purpose, the gallery, having been driven as far as the walls, was carried on to the right and left under the latter, which were supported by props of timber till the time appointed for the assault was come; then, the props being drawn away or consumed by fire, a portion of the rampart fell into the ditch; and the troops, who were kept in readiness, passed over the ruins into the town. Mines of this kind are described in a relation of the siege of the castle of Boves near Amiens, at which siege Philip Augustus attended in person. At the siege of Melun, which was carried on by Henry V., king of England, and the Duke of Burgundy, in the year 1420, the besiegers having driven their mine almost up to the walls, and the besieged having executed a mine in opposition, a barrier was erected where the two galleries met, and there the king and duke fought with lances against two Dauphinois.

As the parties engaged two abreast, it is evident that the galleries must have been a considerable breadth. The old French writers occasionally applied the term mines to what were also then, and are now, called trenches. Thus, at the siege of Harfleur, in 1449, mention is made of broad and deep trenches by which the approach to the wall is said to have been rendered secure; and the same works are immediately afterwards called mines.

Gunpowder was, in 1487, used in military mining by the Genoese at the siege of Serezanella, a town belonging to the Florentines; but on this occasion without success. It is stated, however, in the life of Gonsalvo de Cordova, that Peter of Navarre, a Spanish engineer, formed mines with gunpowder at the siege of Cephalonia, near the end of the 15th century, when the Venetians and Spaniards took the island from the Turks. And in 1503 the same engineer, or, according to Vallière, an Italian called Francis George, succeeded in taking by such a mine the Castle del' Ovo at Naples. This fortress was situated on a rock nearly surrounded by the sea, and had during three years resisted the united arms of the Spaniards and Neapolitans. From that time the practice of forming mines with gunpowder was almost constantly followed in the attack, and after a short time gradually in the defence of fortresses. So powerful was the effect of mines in the attack, that it was not an unusual occurrence for the besiegers after forming their mine to invite the besieged to see it, in order to bring about a surrender without further bloodshed. The besieged from very early times had a gallery placed a short way in advance of the foot of the wall, termed an *envelope* gallery, to warn them of the operations of the besiegers. From this gallery branches were run out, and used to what was termed "give the *camouflet* to the enemy's miners;" that is, a small charge was exploded, which, though insufficient to produce any surface effect, destroyed the besieger's gallery and suffocated his miners. From this to the adoption of ordinary mines was a small step. By means of 1173 mines, great and small, the Venetians defended Candia during more than two years (1666 to 1669) against the whole power of the Turks. By mines also, in 1762, the town of Schweidnitz was defended during 63 days by the Austrians against the Prussians. In the course of this last siege two of the mines fired by the besiegers had charges of powder amounting to 5000 lbs. each; and the depth of the charge below the surface of the ground was from 18 to 20 feet.

In the siege of any place the mining operations of the besiegers are directed to the discovery and destruction of the galleries of countermines; to the blowing up of any advanced works belonging to the garrison; to the demolition of the wall of the counterscarp, in order that the descent into the ditches may be facilitated; and, occasionally, to the formation of breaches in the principal ramparts. On the other hand, the countermines are employed by the defenders to destroy the trenches and batteries of the besiegers beyond the foot of and upon the glacis, the galleries made by the besiegers, and also the lodgments which may be made on the breaches or within the works. It is easy to perceive, therefore, that a system of countermines must add greatly to the strength of a place, by obliging the besieger to proceed with circumspection in his approaches above ground, in order to avoid the risk of being blown up at every step; and, according to Bousmard ('Essai général de Fortification'), if the glacis of a fortress be countermined, the duration of the siege, which otherwise would have extended to one month only, may be prolonged to six weeks.

By means of mines in the attack of a fortress, the besieger has a sure and certain method of gradually, it may be slowly or it may be rapidly, according to the ground, appliances, and activity of the enemy, but still a certain and irresistible means of reaching and destroying the defences of the besieged. And this with the loss of comparatively few men. The successful explosion of a mine by the enemy may destroy a few miners, while an assault costs hundreds or thousands of men. But yet almost every exploded mine is a step in advance for the besieger. Being superior in the field he seizes the crater formed by the explosion, incorporates it in his works, and pushes on from it by fresh galleries. The galleries of both besieger and besieged have been destroyed in the neighbourhood of the crater by the explosion of the mine, whether these were exploded by besieger or besieged. The besieged then pushing on again from his nearest undestroyed gallery, meets the besieger half way, unless, as occasionally happens by skill he circumvents him, but this half way has been a clear loss to the besieged and gain to the besieger. Hence no system of countermines can render a work impregnable; but as a means of delaying the fall of a work, in fact of restoring as far as science can the equilibrium of attack and defence, it exceeds all the other means at the disposal of the besieged: it to a great extent renders the possession of superior numbers, position and material, on the part of the besieger, nugatory. The onward and irresistible advance of the besieger, rapid above ground, from the nature of the work is, though certain, slow in these underground operations. And he cannot neglect them, If the besieged have countermines the besieger cannot refuse to meet him with the same weapons. As the French engineers Gumpertz and Le Brun say, with respect to this, "The loss of a great number of men, and the discouragement of the whole besieging force, perhaps even their defection, would inevitably follow such a resolution. When, therefore, the front of attack is countermined, the besieger must call the miners of his army to his aid."

The great difference between civil and military mining is this. In civil mining the operations generally carried on at a great depth are in solid rock, whereas in military mining they are near the surface in soft ground, which requires supporting to prevent its falling in and crushing or stifling the miner. The principal portion of the art of the military miner consists thus in the management of these supports or linings. In permanent systems of countermines, that is, in fortresses furnished with defensive mines as a portion of their defence, the galleries, being made to last for years, are lined with masonry. Many different systems or plans for the arrangement of countermines have been suggested by the different engineers who have written on the subject. These, though varying much in many details having the same object in view, are to a great extent similar. They are disposed over the exposed portions of the front of fortification, and where an enemy would be likely to form his trenches, lodgments, and breaching batteries, that is, round the ravelins under the glacis, and in front of the bastions in the main ditch and also in the rampart. The object to be kept in view is to expose as little as possible of the galleries to the destructive effect of the enemy's mines; hence they should never, if possible, present their sides to the enemy, as the effect of a mine would be not only to destroy the gallery in its neighbourhood, but perhaps to cut off a large portion of uninjured gallery and render it useless for further defence. The galleries must therefore be disposed so as to present their ends to and lie in the direction of the enemy's approach. At the same time they should not be so far apart that the enemy might pass between them without being heard. As the sound of a pickaxe cannot be heard beyond 60 feet underground, from 100 to 120 feet is the greatest distance they should be asunder. And on the other hand they should be close enough for the mines fired in them to cover the intermediate space with their destructive effects without injuring one another. Assuming then that the galleries are 15 feet under ground, which is considered the best depth for defensive purposes, they should for reasons which will appear from the action of the explosion explained further on, be at central intervals of 48 feet.

Space does not permit of our entering further on this subject: the reader is therefore referred to the article 'Mining, Military,' in the 'Royal Engineer Aide Memoire.' It may be stated, however, that the main gallery which, passing along the counterscarp, serves as the base of the system of mines, is termed the *magistral* gallery; the advanced galleries are termed *listening* galleries. If there be an intermediate gallery, parallel to the magistral, it is called the *envelope*; and those giving access from one to the other, *galleries of communication*.

In offensive mining, the earth is supported by wood-work. There are two different systems of mining, one with what are termed mining frames and sheeting, the other with cases. Mining frames for shafts consist of four pieces, two 4½ feet long, and two 3 feet long, about 4½ inches by 3 inches thick. The long pieces are made with tenons, which fit into mortices cut in the short pieces, which are further notched to one-third of their thickness; these being fitted together form the frames, which are placed horizontally in the shaft at intervals of 4 feet, and retain the sheeting planks, (which are outside them and prevent the earth falling in,) in their places.

Gallery frames differ from shaft frames in being composed of only three pieces, two uprights called stanchions, and a top piece called the capsill.

The system of mining with cases is more expeditious than with frames and sheeting; they have long been known as Dutch cases, and were introduced into the British service by General Sir Charles Pasley. They consist of four pieces about 1 foot wide, namely, two stanchions, a capsill, and a groundsill; and for ordinary work are cut out of 2 inch deal. The stanchions have tenons, 2" long by 3" wide, which fit into mortices of corresponding dimensions cut in the end of the capsill and groundsill. These form rectangular cases, which are placed touching one another if the soil is light, no sheeting being employed.

The dimensions of the different galleries and branches employed in mining are in the clear—

		Height.		Width.
1.	Great Gallery . . .	6 6	×	7 0
2.	Principal Gallery . . .	6 6	×	3 9
3.	Common Gallery . . .	4 6	×	3 0
4.	Great Branch . . .	3 6	×	2 6
5.	Small Branch . . .	2 6	×	2 0

1. Used for the descent of ditches and passage of cannon.
2. Used for the passage of troops, two deep.
3. Ordinarily employed for general purposes of attack, giving the miner room to work easily either on both or one knee, and is the most rapidly executed.

4 & 5. Employed for short distances, about 10 or 12 feet only, for placing charges, &c., as being more easily tamped.

When cases are used, mines can be driven at nearly twice the rate that they can with frames and sheeting: namely, great galleries and shafts about 1 foot an hour, common galleries about 1¼ feet an hour.

Ventilation requires to be well looked after in mines, for not only do the gases generated by the explosions of powder collect in the descending and ascending portions of galleries and often stifle the miner, but even under ordinary circumstances the air is so vitiated by respiration that a branch cannot safely be driven more than 60 feet. Hence openings should be made to the surface of the ground, and, if possible, concealed from the enemy, and communications made from adjacent galleries to create a draught. It also often becomes necessary to use artificial means of forcing air down into a mine, by means of a blower or bellows and metal pipes carried to the end of the mine.

The chamber in which the powder is placed is a cubical excavation formed on one side of the gallery, very little larger than is necessary to enable it to receive the box which contains the powder. When this is deposited, the vertical face of the chamber is covered with boards, which are kept in their places by short timbers fixed in horizontal positions between them and the opposite side of the gallery. The latter is then filled up with earth, well rammed, to an extent in the length of the gallery greater than that of what is called the *line of least resistance;* that is, a line imagined to be drawn from the chamber perpendicularly to the nearest surface where the crater would be formed. The mass of earth thus filling the gallery is called the *tamping* of the mine. A train of powder in a canvas hose, forming a tube about three-quarters of an inch in diameter, and for security contained in a wooden trough called an *auget*, or a *casing-tube*, is laid from the box in the chamber through the tamping to the place where the fire is to be applied; to its extremity is attached a piece of port-fire, which, being lighted, the fire communicates by means of the hose with the powder in the chamber, and an explosion takes place. Mines are also fired by means of what is called Bickford's fuse, which consists of powder encased in a kind of rope made of spun yarn, tarred. This fuse is waterproof, and not so liable to be accidentally ignited, and is especially adapted for damp ground. Electricity is also now constantly employed in firing mines. It was used by the Russians in their mines at Sebastopol, and by the English in the demolition of the docks, &c.

The dimensions of the crater or funnel formed by the explosion depend on the amount of the charge; its form may be considered as an irregular frustum of a cone, or paraboloid, and the mine is denominated *one-lined, two-lined, &c.*, according as the diameter of the crater at the surface of the ground is equal to once, twice, &c., the length of the line of least resistance. Every explosion of this kind necessarily produces a compression of the earth in all directions about the chamber to a certain extent; and the mines formed with high charges have been denominated *globes of compression* from this circumstance. A line drawn from the chamber to the circumference of the crater, on the ground, is considered as the radius of the globe of compression.

The last mentioned description of mine was first employed by Belidor for the purpose of destroying the galleries of the besieger at distances far greater than had before been considered practicable. When a very small, or at least, comparatively to its depth, a very small mine is exploded, no crater is produced, but it is evident that the earth about must be compressed, and galleries, &c., destroyed to a certain distance: the radius of this sphere of compression is termed the radius of rupture. When a crater is produced, the solid compressed will no longer be a spheroid, but an elipsoid, or nearly so, with its major axis passing through the centre of the charge, at right angles to the line of least resistance. With overcharged mines this radius of rupture is greatly increased: in fact it is found that with the ordinary or two-lined crater the radius of rupture, or semi-major axis of the ellipsoid, is 1·7 times the line of least resistance; and the semi-minor axis, or extent of compression downwards, is 1·3 times the line of least resistance. With a globe of compression producing a six-lined crater or maximum charged mine, these lines are 4·36 and 1·4 times the line of least resistance. It will be seen that the lateral effect increases much more than the downward effect, as might be imagined. This great lateral effect was employed by Belidor for destroying the galleries of the besieger: such mines are, from the circumstances of the respective cases, perhaps more applicable by the besieger than the besieged.

The rules for determining the charges of mines are founded on the results of experiment, and it is evident that the charges must vary both with the nature of the soil and with the proposed figure of the mine, that is, with the ratio between the diameter of the crater and the length of the line of least resistance. When a mine of the kind called two-lined is formed in common earth, the amount of the charge in pounds is considered as very nearly equal to one-tenth of the cube of the line of least resistance in feet; but for a three-lined and a four-lined mine it is supposed that the cube of this line should be multiplied by ·21 and by ·45 respectively. It is said that Belidor, somewhere about the years 1758 to 1762, fired three charges of 3600 lbs., at a depth of 12 feet, all of which produced craters of 36 feet radius, or six-lined craters. In an experiment made at Potsdam, when a four-lined mine was formed in a sandy soil by the Prussian Major Le Febvre, the cube of the line of least resistance in feet was very nearly equal to the charge in pounds. According to the latest experiments of the French engineers, the charges of powder necessary to remove one cubic yard (English) of material are as follows :—

Common earth	1·21 pounds (English)
Strong sand	1·64 „
Potters' clay	1·75 „
Loose sand	1·85 „
Old masonry	1·94 „
Freestone	2·14 „

Now the figure of the crater being supposed to be a paraboloid, of which the centre of the chamber is the focus—if a be the length of the line of least resistance in yards, and $n\,a$ represent the radius of the crater at the surface of the ground, also if $\pi = 3{\cdot}1416$, we shall have

$$a^3\frac{n^2\pi}{4}(1+\sqrt{n^2+1})$$

for the volume of the crater in cubic yards; therefore, multiplying this volume by the numbers in the above table, we should have the charge in pounds, which will hold good for mines up to three-lined craters.

The following rules, given by General Sir Charles Pasley, are very valuable, as deduced from experiment. L.L.R. meaning line of least resistance.

CHARGES AND EFFECTS PRODUCED IN MIXED EARTH.

To find the quantity of powder.	Multiply by	Gives powder in lbs. to produce No. lined crater.	Earth thrown out in depth.	Earth affected in depth.	Remarks.
L.L.R.^{3}	$\frac{1}{30}$	1-lined	Not defined	..	These experiments were in soil weighing from 90 to 122 lbs. the foot cube, and on a L.L.R. of 6 feet. If more than 3-lined craters are not attempted the charges are pretty certain; above this they are not so certain; it is therefore better to use a number of small charges to produce a certain effect than one large one, the latter being very wasteful of gunpowder. In earth, try to produce 3-lined craters at 2-lined intervals, and never with a L.L.R. less than 6 feet. Earth and stones were with a 5-lined crater thrown 180 yards, with a 6-lined 270 yards, and with a 7½-lined 600 yards.
„	$\frac{1}{20}$	1½-lined	„	..	
„	$\frac{1}{10}$	2-lined	„	..	
„	$\frac{1}{4}$	3-lined	„	..	
„	„	4-lined	L.L.R.	1⅔ L.L.R.	
„	2½	5-lined	1¼ L.L.R.	2 L.L.R.	
„	4	6-lined	1½ L.L.R.	2 L.L.R.	
„	8½	7-lined	..	..	
„	9½	7½-lined	1⅘ L.L.R.	2½ L.L.R.	

In order to determine the proper size of the chamber, or rather of the box, which is to contain the powder, it will be necessary to observe that one pound of gunpowder occupies, in volume, about 30 cubic inches.

Experience has shown that the greater the charge of powder, the greater is the quantity of earth removed by the explosion. But this fact has its limits; for when the charge is considerable, since the whole of the powder does not take fire instantaneously, it will happen that the earth is partially displaced before the inflammation is complete so that fissures being formed in the ground, the force of the powder is spent in the air without producing any effect. Hence it may be concluded that there is a certain charge of powder which will produce a maximum of effect; and it is supposed by Belidor that, in earth of mean tenacity, the greatest craters will have their diameters, at the surface of the ground, equal to about six times the length of the line of least resistance.

MINIATURE. The term miniature would apply with equal propriety to every kind of painting executed on a minute or diminutive scale; but as commonly employed it includes only two, though somewhat widely different, kinds of painting. One of these is that style of ornamental painting, or illuminating, which is seen in its greatest perfection on the vellum pages of mediæval bibles, psalters, service-books, and other costly manuscripts: the other kind is that of small portraits executed chiefly on ivory, to which indeed the term has in its popular acceptation been of late years almost exclusively confined.

We will notice first the former kind of miniatures. The practice of enriching manuscripts with small paintings is very ancient. Many of the Egyptian papyri exhibit in their coloured hieroglyphics what are in their way admirable examples of miniature painting. These are painted in very vivid colours, and often display much artistic skill in their execution. From the marvellous skill and patience shown by the Greeks in the engraving of small figures on gems, we may conclude that they could paint with equal skill on a small scale, but we do not know that they practised this kind of painting to any extent. Among the Romans, books were occasionally adorned with small paintings in a very costly style for noble and wealthy persons. Pliny ('Hist. Nat.' xxxv. 2.) relates that Marcus Varro's work entitled 'Hebdomades' consisted of brief biographies of 700 illustrious men, from Homer downwards, each being accompanied by a portrait. There has been considerable discussion as to the manner in which these portraits were executed, some, and Müller amongst them, supposing that they were produced by a reproductive process—a sort of engraving and printing in fact—which enabled them to be repeated in each copy of the work. It is more probable that they were drawings or paintings though perhaps not of a very elaborate description. Seneca, Martial, and other writers refer to the practice of adorning manuscripts with painted illustrations.

In the decline of art the practice was preserved by the artists of Byzantium. Some writers believe that in the existing Byzantine miniatures we have in fact the connecting link between ancient and modern painting. But there is nothing in the character of these works to support the suggestion that the artists had inherited the traditions of the painters of ancient Greece. The earliest works were uncouth in drawing and barbarous in design, and owe both in general style and colour something to oriental taste. Yet they are of exceeding value as indicative of the character of the earliest dawnings of the revival of art under Christian influence. And as long as the practice continued of adorning manuscripts with these works they retain their value as documents in the history of art—representing on the whole faithfully its condition at the various periods, and in its earlier stages being almost the only examples of painting that have come down to us. These illuminations are also of great value, apart from their worth as works of art, as illustrating the costume, weapons, and even the architecture of their time.

The oldest existing manuscripts with miniatures are Byzantine, and of the latter part of the 4th, or beginning of the 5th century. During the first centuries, pictorial representations were studiously discouraged by the bishops of the church; but this was changed in the 4th century, and thenceforward we find the practice of illuminating manuscripts to have generally prevailed—the painters, being for the most part, monks, and a scriptorium, or establishment for writing and illuminating manuscripts, being attached to almost every wealthy monastery. The earliest extant illuminated Byzantine manuscripts are a book of Genesis in the Imperial Library at Vienna; one similar in subject and character, but fuller of miniatures, which formed one of the treasures of the Cottonian collection, but was unhappily almost destroyed by the fire at Ashburnham House; and a Virgil in the Vatican. The Vienna manuscript has the text chiefly in gold and silver, and is adorned with 88 miniatures; the Vatican Virgil contains 50 miniatures, the text being written in capital letters and in black ink. The Vatican Virgil was engraved by P. S. Bartoli (1677), at the expense of Cardinal C. Massimi, but the engraver corrected both the drawing and chiaroscuro, in accordance with the taste of his day, and the engravings are consequently valueless for any historical or critical purpose. More accurate outlines of them are given by D'Agincourt, 'Hist. de l'Art par les Monumens,' Peint. tab. 20-25. In the same work are given outline tracings of the miniatures of the best known manuscripts, which will enable the student to follow the fluctuating progress of the art in the hands of the Byzantine miniatori, to its greatest excellence about the 10th century, and thence trace its decline to the 13th century, and its temporary revival and termination, as far as Greece is concerned, in the 14th. Outline illustrations are also given in the same work of the miniatures of Italy, France, &c. A good notion of the style of colour of the different schools of mediæval miniatori will be obtained from the drawings by Mr. Owen Jones in the splendid work of Mr. H. N. Humphreys, 'The Illuminated Books of the Middle Ages' (fol., 1849).

The manner of the Byzantine miniatori was naturally imitated by those of the Italian monasteries, who followed very closely the types of their predecessors in their representations of the Saviour, the Virgin, and the Saints. As late as the 13th century the miniatori of Italy were mere feeble imitators; but by the beginning of the 15th century, they had assumed a higher place than their Greek masters, and works were produced in the Italian monasteries which in their way have never been surpassed for devotional feeling, elevation of sentiment, and the combination of a certain mystical grace and tenderness with ascetic severity. In their technical qualities these Italian miniatures are also of high excellence. The drawing, though still stiff, is pure and noble; the colour brilliant, yet harmonious, and the pencilling singularly light and neat. Vasari has given a particular account of several painters who distinguished themselves in this line of art, which though still chiefly practised in the monasteries, was, in the 15th and 16th centuries, no longer exclusively so. Oderigi da Gubbio, Giotto, Giralamo dai Libri, Giulio Clovio, Fra Angelico da Fiesole, Attavante, and several other painters, were also celebrated for their miniatures. Not only were illuminated manuscripts prepared for religious establishments, but the best artists found ample employment in the illumination of both secular and religious manuscripts for the chiefs of the princely houses of Italy. As the painting of larger pictures improved, however, miniatures became less in request, and in Italy as elsewhere, the production of illuminated manuscripts rapidly declined after the invention of printing.

The earliest school of miniature painters in the west of Europe appears to have been that founded at Finian in Ireland, in the first half of the 6th century, by St. Columba, who somewhat later founded a still more celebrated monastery at Iona, which was transferred a few years after to Lindisfarne. Several illuminated manuscripts, the work of Irish miniatori, are in the library of Trinity College, Dublin; one at least of them, a book of the Gospels, known as 'the Book of Kells' being regarded as contemporaneous with Columba, if not the work of his hands. These Irish manuscripts are most remarkable for their borders, and other ornamental work, which are drawn with surprising delicacy and freedom, and are full of a playful and ingenious fancy, while the drawing of the human figure is ungainly and disproportioned, and the colour crude and conventional. It seems to be agreed that the other schools of the west of Europe derived their first impulse more or less immediately from that of Ireland. The art flourished in England during the Anglo-Saxon period, and the peculiarities of the Irish style of ornamentation are in it unmistakeably evident. The perfection to which the art had arrived at this time in England, is shown in the splendid manuscript of the Latin Gospels, known as the 'Durham Book,' executed between 698 and 720, and which is now in the British Museum; and in the no less famous Benedictional of St. Ethelwold, now the property of the Duke of Devonshire. It was an Anglo-Saxon monk, Alcuin, who, at the invitation of Charlemagne, established the earliest schools for missal painting in the Frankish empire, the most important being those of St. Martin, at Tours, and Aix-la-Chapelle. Several of the early productions of these schools are extant, and show manifest traces of their origin. One of these, the Bible found in the tomb of Charlemagne, and now in the monastery of San Calisto, at Rome, is one of the most magnificent works of the kind in existence. Later, the art was prosecuted with eminent success in France, and a thoroughly national style was developed which attained its greatest perfection in the latter part of the 13th century.

In Germany and the Low Countries, the art took root somewhat later; but it ultimately attained a high degree of excellence. The museums of Germany and Brussels are rich in illuminated manuscripts of native production. By many, Memmling, the Flemish painter, is regarded as the greatest master of miniature painting, not excepting those of Italy. In England the art was a good deal modified after the Norman conquest by the prevalence of the French taste introduced by foreign monks; but the national spirit resumed its predominancy, and the English illuminations of the 13th and 14th centuries will bear comparison with the best contemporary productions of any other country. One of the finest remaining English manuscripts is the Willoughby, or Queen Mary's Psalter, painted early in the 14th century—a work full of life and spirit, admirable alike in design, drawing, colour, and execution. The art appears to have been practised in England down to the reign of Henry VII.

In the miniature painting of different ages and countries, there is of course, great diversity, not merely of style, but of modes of execution. Generally, however, it may be said, that the miniatures were painted on the vellum or paper with colours very finely levigated, and rendered opaque by being, for the shadows as well as the lights, mixed with white—the usual vehicle being gum, glue, or white of egg. D'Agincourt notices some miniatures, the colours of which are insoluble in water, and Dr. Dibdin speaks of others which seem to have been mixed with oil; but this is probably a mistake. In some manuscripts the artists appear to have covered their finished miniatures with a transparent wash of glue or varnish, which has materially assisted in their preservation. The colours used were not only selected and prepared with great care, but of the brightest hues, and applied and combined with much skill. Gold is freely used, gold back-grounds being frequent at most periods.

Notwithstanding the large number which must have perished from accident or neglect, or have been wilfully destroyed, the number of richly illuminated manuscripts still existing is surprisingly great. Most public, and many private collections contain numerous examples, and copies are eagerly purchased at very high prices whenever offered for sale. The Vatican, the Imperial Libraries of Vienna and Paris, and the British Museum are especially rich in examples of the various schools and periods; the monasteries of Italy, and the libraries of Oxford, Cambridge, and Trinity College, Dublin, also possess numerous and important, though less various collections.

We have now to speak of what are popularly known as *Miniatures*—the small portraits executed on ivory, either for decorative purposes, or to place in cabinets, lockets, or brooches. Miniatures painted in enamel are noticed under ENAMELS.

Although of later date than the works of which we have been speaking, portrait miniatures are by no means of recent introduction. Portraits were among the embellishments introduced by the mediæval miniatori in the manuscripts executed by them for noble patrons; and after the decline of the practice of illuminating books, the production of portrait miniatures for placing in lockets, frames, or cabinets, seems to have quickly grown into fashion. Ivory was early adopted as a more suitable ground than vellum for independent works, and its adoption led to a change in the technical processes. In mediæval miniatures, body colours—or colours rendered opaque by the admixture of white—were alone employed, and the ground or vellum was entirely concealed, the brilliancy of effect being obtained by the colours themselves. In modern portrait miniatures, the painters have very generally employed transparent colours, at least for the flesh tints; finding that the peculiar texture and semi-transparency of the ivory by showing through the tints of transparent colours caused them to "bear out," as it is termed, with great brilliancy, besides imparting an exquisite softness, and much of that "inner light" which is so pleasing in carnations.

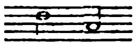
The ivory for miniatures is cut in very thin sheets, so as to retain as much as possible of its semi-diaphonous character, and when mounted, is "backed" by some perfectly white material. The painting is executed in water-colours, but by a process differing entirely from that known as water-colour painting. Ivory having a smooth and non-absorbent surface, the colour cannot be floated on in washes, or flat tints, laid one over another. The flesh tints and other parts requiring great delicacy of finish, are therefore entirely dotted, stippled, or hatched upon the surface. In the draperies and back-grounds, the colours are however often washed in with flat tints, the inequalities of tint or surface being afterwards got rid of, and the whole worked up by careful stippling. A mezzotinto scraper, and sometimes an engraver's point or needle, is used for removing lights, securing due graduation of tints, &c. Gum is the only vehicle used with the colours besides water. Formerly, it was usual to execute the drapery and background of miniatures in body-colours, but the value of the ivory surface is thus lost, and the brilliancy lessened; while the general balance and harmony are almost always injured by the combination of opaque with transparent colours. The use of opaque colours has therefore been almost entirely abandoned by the best English miniature painters; though retained by French artists, who, it must be confessed, have employed them with great tact and skill.

Until of late years miniatures were almost invariably confined to the face and bust of a figure. They now often comprise the entire person, with all the accessories common to a "whole-length" portrait on canvas, and are painted on a sheet of ivory of a size which almost removes them from the class of minatures. The process is, however, the same in these as in the bust portrait, where the adoption of a larger scale does not call for a somewhat larger handling. Sheets of ivory of sufficient size for these large miniatures—as we must call them for want of a more appropriate term—cannot, of course, be cut from the diameter of an elephant's tusk, as are those for miniatures of the ordinary size. They are, in fact, thin veneers sawn from the circumference of the tooth, as described under Ivory, steamed and flattened under hydraulic pressure, and fastened with a composition of india-rubber to a mahogany panel. Some of these large paintings on ivory, as executed by Mr. Thorburn and others, have a broad and masterly effect; but they are after all hardly to be regarded as miniatures, and certainly do not possess the special characteristics of works of that class.

From the nature of the process miniature-painting requires great refinement of taste, dexterity and delicacy of hand, and patience in the artist. It recommends itself by the extreme softness, delicacy, and brilliancy of colour, and the portability and durability of its productions; and it has been pursued with great diligence and success in most countries, but especially in England, France and Italy. From the first the art has been successfully prosecuted in England. It appears to have been introduced by foreigners; but from the time of Nicholas Hilliard, limner to Queen Elizabeth and her successor, who learned the art from Holbein, England has always possessed miniature painters at least on a level with the best of their contemporaries. Among the immediate successors of Hilliard were Isaac and Peter Oliver, from the former of whom, in some respects still unrivalled as a miniature painter, we have portraits of several of the most illustrious of the remarkable men of his time. To them succeeded Alexander Hoskins and Samuel Cooper, and the latter, scarce inferior even to Isaac Oliver, has preserved the best likenesses of several of the most famous of the Commonwealth men, including Oliver Cromwell and John Milton. We need not continue the list: it will be enough to say that, whilst English miniature painters have always occupied a foremost place in their branch of art, it has been admitted even by foreign critics, that the English miniatures of the last and present generation unquestionably take precedence of those of the Continent. But whilst the artists have secured so honourable a position, the art itself appears doomed to give way before the advance of photography, as the miniature-painting of the mediævalists did before printing. Some of the best of our living miniature-painters have wholly or in part abandoned the practice of this branch of painting, and others of an inferior order are devoting themselves to painting "photographic miniatures," or miniatures of which the basis is a feebly developed photographic positive. It is however to be hoped that fashion may show sufficient encouragement to the true miniature painter to preserve from decay this delightful branch of art. The practice of painting photographic miniatures can hardly fail to develope a mechanical mode of painting which can scarcely rank as a fine art, however advantageous the study of photographic portraits may be, as an aid, to the miniature painter.

We cannot refer to a collection of portrait miniatures in either of our national museums; but several private collections have been formed in emulation, and partly from the débris, of the famous Strawberry Hill collection of Horace Walpole. Among the most celebrated are those of the Dukes of Portland, Buccleuch, Hamilton, Marlborough, and Northumberland, which embrace a large number of specimens from the Tudor period downwards. A choice selection from these and other collections was brought together at the Manchester Art Treasures' Exhibition of 1857; and another, but comparatively private exhibition, was made partly from the same collections by the Archæological Institute, London, in the summer of 1860.

MINIM, in Music, a character, or note, formed of a round open head, and a stem descending or ascending from its right side—



When first introduced, the minim was the shortest note in music, as its name (from *minimus*, the least) indicates. It is half as long in duration as the semibreve, and double that of the crotchet. [Crotchet.]

MINIMS, or MINIMI, also called Pauliners, an order of religious whose asceticism exceeded even that of the Franciscans, of whom they were considered a branch. They were instituted about the year 1436, by Saint Francis de Paula, under the name of Hermits of Saint Francis, and confirmed in 1474 by Sixtus IV. Alexander II. changed the name of the order to that of *Minims*, as marking the humility of their order. In France they had the name of *Bons-hommes;* and in Spain that of the *Fathers of Victory*, in consequence of Ferdinand IV. gaining a victory over the Moors, according to a prediction of Saint Francis de Paula. In Spain a convent of nuns of this order was founded as early as 1495, followed in the course of time by other similar establishments. In France there was no female convent of this order till 1621: when one was established at Abbeville, and another subsequently at Soissons. No house of this order was ever established in England.

MINING. The art of mining embraces the contrivance and management of the operations necessary to effect the various objects requisite in a mine, as the discovery of mineral deposits, the preliminary trials of the value, and the final extraction of their produce by means of suitable excavations and the application of the requisite machinery. These occupations may be said to constitute the business of the miner in the more comprehensive signification of the term, and it will be evident that they demand an extensive range of acquirements in which knowledge, both practical and scientific, must be blended.

History of Mining.—A regular or detailed history of mining, however interesting in itself, would far exceed the limits of this article; we shall therefore briefly glance over some of the most important steps by which mankind have been led to their present bold and extensive operations for the extraction of metals and other mineral substances. The use of the metals, and consequently some process for their extraction and separation, may be traced to the most remote antiquity, and is there lost in the obscurity which veils the early history of our species. Moses ascribes the first use and manufacture of the metals to Tubal-Cain, the seventh in descent from Adam, who is said to have been the "instructor of every artificer in brass and iron." Upon so brief a notice we are not entitled to build much, but it proves nevertheless that the use of the metals is almost coeval with the human race. Profane history likewise shows that it was known to the earliest nations of antiquity, as to the Assyrians, the Greeks, and Egyptians. Gold and silver were abundant among the ancients; an alloy of copper and tin formed the armour and weapons of the Greeks, although iron was not unknown among them, and of this metal the Roman weapons were formed. These facts do not, however, imply any great knowledge of mining, properly so called, as it is well known that metalliferous deposits are often found near the surface, frequently in a state of extreme purity, as gold and copper for example; and in early ages, when they had been so much less ransacked by the miner, these superficial deposits must have been much more abundant than at present, and probably furnished a large proportion of the metallic produce of those times. Most of the mines of antiquity were probably of a similar nature to the stream-works of Cornwall, and it appears from Strabo[*] (175, Casaub.) that the Phœnicians at that early time used to trade to Cornwall for tin and lead. In early times the demand for the metals could not have been very great; their use was then either as instruments of luxury or war, and thus confined to a limited class, so the quantity found near the surface was in all probability fully adequate, leaving but little inducement for deeper and more laborious research.

There is, however, evidence enough to show that operations similar to those of modern mining were carried on by the nations of antiquity. Herodotus (vi. 46, 47) observes that a mountain in the island of Thasos was completely burrowed by the Phœnicians in their search for the precious metals; and the curious fragment of Agatharchides preserved in Diodorus (b. iii. ch. 12, 13) shows that the art of forming shafts and passages for exploring mines and procuring the metals was well known in Egypt. The silver mines of Laurium in Attica were worked by the Athenians, to some extent at least, as early as the beginning of the 4th century B.C. Under the Romans the quicksilver mines of Almaden in Spain, and the lead and iron mines of Sardinia [MERCURY, in NAT. HIST. DIV.], were extensively worked.

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[*] Strabo speaks of the Cassiterides, which can be no other place than Cornwall or the Scilly Islands; probably the former.

It is singular to observe that an art for which this country possesses such great natural facilities, and which was certainly cultivated here both before the Roman conquest and during the Roman occupation of this island, should afterwards have fallen into decay, and indeed for a time have been chiefly practised by foreigners. Prior to the Norman conquest our mines had been much neglected, probably in consequence of incessant civil commotion; and subsequently to this period they were chiefly worked by Jews. In the reign of Elizabeth the art of mining had fallen into so much decay that an importation of foreign skill was found necessary to revive it; and the Germans, long and justly celebrated as skilful miners, received every encouragement to settle in this country and turn their attention to them. From this measure some success appears to have resulted, and in the following reign we find Sir Hugh Middleton, a citizen of London, deeply concerned in the lead and silver mines of Cardiganshire, from which he derived a large revenue, which was expended in that noble work from which the metropolis still benefits—the formation of the New River. About this time a new and important auxiliary was furnished to the art of mining by the application of gunpowder for blasting, which appears to have been first practised in Hungary or Germany; and an invention which had revolutionised the art of war thus became the means of effecting an equally extensive change in one of the most prominent arts of peace.

In the early part of the 18th century another important event took place in the history of English mining. The rich deposits of copper which have long constituted the principal mineral wealth of Cornwall, had up to this time been neglected, partly perhaps from this ore being confounded with "mundic," or worthless iron pyrites, common in most mines, and partly from its lying deeper in the veins than the ores of tin, which had always formed the chief object of search. When at length the nature and value of the Cornish copper ore was fully recognised, a powerful stimulus was given to this new branch of mining, which has been carried on to the present time with great and increasing activity, the copper-mines of that county being now the deepest, the most extensive, and most productive in the world.

The great invention of the steam-engine, the progress of which during the last century exercised such vast influence upon our arts and manufactures, was early rendered applicable to mining in this country, and in a great degree contributed to the present perfect state of the art. Savery, who, if we except the somewhat equivocal claims of the Marquis of Worcester to that honour, was the first person who constructed a practically useful engine worked by steam, sought in the first instance the patronage of persons interested in mines, as we see by his publication entitled the 'Miner's Friend,' in which he describes the nature of his invention and its applicability to draining mines. At this period our mines, although comparatively shallow, were much inconvenienced by water, especially those which were not in situations where hydraulic machines could be employed, and hence the application to them of this new power was at once obvious. The introduction of Savery's engine into our mining districts probably led to the great improvements effected by Newcomen, a resident in Devonshire, which vastly extended its utility, and indeed completely altered its principle. Their conjoined patent was taken out in 1705, and from that date the steam (or rather, atmospheric) engine became a most useful auxiliary in the hands of the miner, and was very generally employed for draining mines, not only in Cornwall, but in the coal-mines of Staffordshire and the north of England. The great improvements introduced by Watt in 1765 and succeeding years were quickly appreciated by the mining interest, and his engines were speedily introduced into the mining districts of Cornwall, where they effected a great saving of fuel, and therefore of expense, the coal used in that county being brought from South Wales. It is chiefly to the object of economy that the efforts of late engineers have been directed, and so successfully, that their improvements have fully kept pace with the increasing depth of our mines, many of the most abundant of which would have long since been abandoned had not this been the case. These great improvements have chiefly originated in Cornwall, where ingenuity has been stimulated by the high price of coal; and among the numerous individuals who have contributed to them, the names of Woolf, Trevithick, and Grose may be particularly mentioned.

The improvements in the manufacture of iron which took place in the latter part of the last century, while they vastly increased the demand for it, and thus gave a great stimulus to the working of this metal, and of coal also for its reduction, contributed much to the perfection of mining generally, by enabling the miner to employ iron pumps instead of wooden ones, which were before used. This change allowed a better construction and arrangement of the pit-work, one of the most important apparatus employed in mining, and hence greater depths have been attainable than might otherwise have been the case. Among many minor improvements which may be traced to the same source may also be mentioned the laying down of iron tram-roads underground in mines, as well as their use upon the surface: the carriage of the mineral to different parts of the works has thus been greatly facilitated and economised.

Simultaneously with the improved machinery and apparatus introduced towards the close of the last century, great improvements also took place in the internal economy of mines and the arrangements of the underground works. The ancient mode of following down the ore by irregular isolated excavations, and of stoping the bottoms of the mines in the German manner, gave place to the present system of laying open the ground for discovery and extraction, by a well-arranged series of shafts, levels, and winzes. By this plan the ore or mineral is divided into more convenient masses for extraction, and can be worked much more economically than by the former mode of stoping or cutting away the ground in the bottom of the levels, as still practised on the Continent.

The most recent improvements which have been introduced into mining are those which regard the mechanical treatment of the ores after they have been extracted from the mine, and previous to their being fit for the furnace. The processes used for this purpose are technically termed "washing" and "dressing," by means of which the ore is freed from many of its earthy impurities, and thus rendered much richer for metal, in an equal bulk. In effecting this object several kinds of apparatus are employed, chiefly the stamping-mill, the crushing-mill, and the jigging-machine, the use of which has been known from time immemorial; but more attention has latterly been paid to their application, and it has also become far more general, to the great benefit of all mines, especially those in which a large proportion of the poorer ores are obtained. The competition with foreign mines, in which labour can be obtained more cheaply than in this country, has done much to promote this class of improvements, which, though less striking than some others, have, within the last few years, been productive of extremely beneficial effects, and may still be considered as in progress.

The history of coal-mining is in great measure distinct from that branch of the art which we have been tracing, and which chiefly relates to the extraction of the metals. The introduction of gunpowder, the invention of the steam-engine, and the improved manufacture of iron, have formed however epochs of common importance to both, having greatly contributed to the present extended scale upon which our coal-mines are worked. The great objects to which improvement has within the present century been directed are the ventilation of the works and the invention of lamps which should not be liable to explosion on contact with the fire-damp. The system of ventilation in our collieries has been greatly improved of late years by Mr. Buddle and others; and the beautiful and well-known invention of the safety-lamp, in 1815, by Sir Humphry Davy, has afforded the miner a valuable though not in all cases an effectual preservative against explosion. [LAMP, SAFETY.]

One of the most important events in the recent history of mining in this country is the establishment of suitable means of instruction for the mining engineer. This desideratum was first supplied by the university of Durham, which opened a class for instruction in civil and mining engineering, in January, 1838. In the latter part of the same year a similar department was opened in King's College, London; and a similar institution was organised by Sir Charles Lemon at Truro, in Cornwall, but, unfortunately, it did not meet with the support it so justly merited, and has since been discontinued. The local positions of the Durham University and of the Truro institution were highly favourable to the joint acquisition of theoretical and practical instruction—an advantage in which neither King's College nor the Government School of Mines in Jermyn Street can participate, although both must afford valuable preliminary instruction to the mining engineer. These various institutions can hardly fail, in time, to produce an important effect on the mining industry of this country.

Mineral Deposits.—In proceeding to treat of the practice of mining, some preliminary details will be useful; for as mining operations are of course in great measure regulated by the nature of the mineral or metalliferous deposits to which they are directed, and by which are determined the form and construction of the mine, and much of its internal economy, it will be necessary briefly to glance at this subject, and to point out some of the most important modes in which mineral masses are presented by nature to our research. Of the various classes into which mineral deposits may be divided, it will be sufficient for our present purpose to notice four only,—*veins, beds, masses,* and *fragmentary deposits,*—each of which is the repository of vast mineral treasures, but more especially the first two.

Veins have originally been, in most cases, long, narrow, and irregular fissures, traversing the rocky crust of the globe, which they penetrate to an unknown depth, and often at a high angle of inclination. They are for the most part filled with sparry and stony substances, called the "veinstone," or the "gangue" of the vein, but contain here and there irregular masses or "bunches" of the metallic ores, often of immense size and value, and which it is the principal business of the miner to discover and extract. Most of the metals are of common occurrence in veins, as, in this country, copper, tin, lead, and zinc, to which, in other parts of the world, may be added gold and silver.

Beds are layers of mineral substances interposed between the strata of solid rock, which, except in their containing valuable matter, they very much resemble. The layers of flint, which may be often seen imbedded in chalk wherever a section of this rock is made, will convey a good idea of a mineral-bed. Several of the metals, especially lead, are occasionally found in beds; coal, clay-ironstone, and rock-salt exclusively so; but the last-mentioned mineral is far less regular and continuous than the former.

Masses, or "pipe-veins," as they are often termed by the miner, are not so easily defined: the best idea which can be given of them is that of an irregular branching cavity descending either vertically or obliquely into the rock, and filled up with metalliferous matter. Deposits of this nature are less common than the two former classes; they usually contain either copper or lead, and some of the rich oxides of iron appear to belong to a similar formation.

Fragmentary Deposits occur associated with and indeed forming part of many of the loose superficial beds of sand and gravel which occur in the valleys of mineral districts, consisting of the detritus of the neighbouring mountains, which has been washed down from thence at remote geographical epochs. The mineral substances found in these deposits, which may be considered as having originally been derived from veins or beds in the vicinity, are not, in most cases, mixed up indiscriminately with the alluvial matter, their greater specific gravity having occasioned them to be deposited in distinct layers by themselves, usually towards the bottom of the mass. Tin and gold are the metals which most commonly occur in deposits of this kind.

Geological Position.—The above-mentioned mineral and metalliferous deposits are not found promiscuously distributed throughout all rocks or soils; on the contrary, there are certain rocks, or rather assemblages of rocks, to which they may be considered as in a great measure peculiar. Granite, porphyry, and the older igneous rocks, generally are metalliferous, and often eminently so; but mineral deposits are on the whole most abundant in rocks of sedimentary origin, and more especially in and near situations where these two classes of rocks (the igneous and sedimentary) are in contact, or where a metamorphic structure has, from the action of internal causes, been superinduced upon the latter. It does not appear that nature has confined particular metals to any exclusive kind of rock, yet traces of a general association may still be perceived. Thus, tin, copper, gold, silver, and certain deposits of iron, are most abundant in the class of rocks usually termed primary; while lead, zinc, mercury, and the earthy ores of iron, are most abundant in the older secondary rocks, which also contain our principal deposits of rock-salt. Veins are of most common occurrence in igneous and primary or metamorphic rocks, in the vicinity of which the derivative fragmentary deposits are therefore most often found. Mineral-beds, although sometimes occurring in primary rocks, are most common in secondary countries; and irregular masses, or pipe-veins, are most strikingly developed in limestone districts, where they probably occupy original cavities in the rock.

Metallic Ores and Mineralising Substances.—The state in which the metals are found, the full consideration of which belongs to chemistry and mineralogy, will next require our attention, so far as it is immediately connected with the business of the miner. It must be well known that the metals are very rarely presented to us in a pure or metallic state, although native masses of copper and iron are occasionally met with; but gold, from its small affinity for oxygen and other mineralising substances, although frequently alloyed, is never mineralised. The great bulk of the metals then, with the exception of gold, are found in the state of *ores*, that is, chemically combined with certain mineralising substances, which completely disguise, and, in fact, till separated by metallurgical processes, destroy their usually recognised and useful properties. The most important of these mineralising bodies are oxygen and sulphur; the next in rank are chlorine, and the sulphuric, carbonic, and phosphoric acids. The mode in which they combine with the metals is in binary compounds. Of the former we have examples in iron, lead, and mercury, which, when mineralised by sulphur, form respectively the following sulphurets, iron pyrites, galena, and cinnabar: we observe the latter in all cases where the metals are mineralised by acids, as in spathose iron-ore, or carbonate of iron, in which one binary compound, the oxide of iron, is united to another element, the carbonic acid. From this naturally compound state, in which the metals almost invariably occur, arises the art of metallurgy, which, although generally considered totally distinct from that of mining, is nevertheless most intimately connected with it.

Earthy Impurities.—Independently, however, of those chemical combinations from which the metals can only be freed by the smelter when treated in the furnace, there are other mechanical impurities scarcely less important, which require to be partially separated on the mine, and which therefore fall entirely within the province of the miner. Although large masses of the metallic ores, as before noticed, are concentrated in bunches or deposits, confined to particular portions of the vein, there is also a great proportion of the ore in all mines, which is more or less intermixed with the veinstone, or often indeed finely disseminated through it; and as the expense of fusing this large mass of earthy matter would greatly exceed the value of the metal which it contains, while on the other hand it forms too large a proportion of the produce of most mines to be thrown aside and rejected, great skill has been shown in all mining countries in contriving mechanical processes for effecting its separation as soon as extracted from the mine. When this separation has been properly accomplished, the metallic residue, before worthless, can be profitably smelted, to the great benefit of all, more especially the poorer class of mines, while those in which the precious metals are worked are entirely dependent for their existence upon the skill and care with which it is performed. The mechanical impurities here spoken of are often sufficiently obvious even in hand specimens of the metallic ores, which, unless purposely selected from the richest parts of the vein, will often exhibit thin alternate layers of the ore and veinstone, or sometimes irregular masses of ore of different sizes which are completely intermixed with and imbedded in sparry and stony matter, and this must be considered the character of a very large proportion of ores in their natural state. It frequently happens too that ores of a worthless character are mixed up with the more valuable ones; thus, copper and lead are very generally accompanied by iron pyrites and blende, both of which must be regarded as impurities, and therefore separated as far as possible previous to any process in the furnace. The great bulk of the metallic ores, when in their natural situation, constitute in fact a most heterogeneous mixture, in which the really valuable metal exists only in a small proportion, chemically combined with one or more mineralising substances, and completely intermixed with sparry and earthy matter and ores of inferior metals. A proper perception of this fact, which is scarcely noticed in works on mineralogy, is most essential to a right understanding of the art of mining, and of the various ingenious processes which in this and other countries have arisen out of it, having for their object the separation and concentration of the metallic matter drawn from the mine, previously to its being submitted to the action of fire.

Preliminary Mining Operations.—As the construction of a mine, or the arrangement of the underground works, must depend in a great measure upon the nature of the mineral deposit to be wrought, if we refer to the great division of mineral deposits into veins and beds, before noticed, it is evident that this construction must be principally of two kinds, adapted to each of the above cases, independently of the less definite processes adapted to the working of irregular mineral masses and fragmentary deposits. Thus, in working a mineral vein, as in a copper or tin mine, the excavations will be formed either vertically or in a highly inclined position, and pursued laterally, or, as the miner terms it, "upon the course of the vein," while the advanced points tend progressively downwards, or "in depth." In working a mineral bed, on the contrary, taking a coal-mine for example, the principal excavations will be formed horizontally around the pit or shaft by which access is first obtained to the deposit.

As a very large portion of the metallic produce extracted by the miner from the earth, and more especially of the soft metals, copper, tin, and lead, is derived from veins, it is to the former of these arrangements that attention will be first directed. The working of coal and iron is considered hereafter, together with that of those minerals which are found in more irregular deposits. The general view of mining which falls within the limits of this article may conveniently be divided into the following considerations: the discovery of mineral veins or other deposits; the first opening of a mine and subsequent extension of the workings; the machinery and other appendages required by these operations, both underground and at the surface, with a brief notice of the surface works, and of mining economy and statistics.

Works of Discovery.—Mineral veins or beds are seldom visible at the surface of the ground, being generally concealed by the thick covering of diluvial matter which is spread over almost every portion of the globe, and hides from our view the solid rocky strata in which they are enclosed. In some cases however where this covering is partially wanting, they may be distinctly traced at the surface, and still more frequently they are rendered visible by the indentation of excavated valleys, and the channels worn by mountain torrents. The same effect is often produced by cliffs on the sea-shore, where veins occur in that situation, of which there are many examples on the coast of Cornwall.

As mineral deposits however present in most cases no trace of their existence at the surface, certain general indications must be had recourse to for their discovery. The most general of these indications (which can be but briefly noticed here) are furnished by geology, which teaches us that certain metals are most abundantly found in certain rocks, and further points out that they do not occupy any position indiscriminately in those rocks, but are almost exclusively found near their junction with other rocks of a different character, more especially near the contact of igneous masses with sedimentary strata, and that they commonly occur where rocks alternate together, and are broken and dislocated. Thus the tin and copper veins of Cornwall are situated chiefly in a species of clay-slate provincially termed "killas," and either near its junction with protruded masses of granite, or where it is intersected by channels of a porphyritic rock termed "elvan." In Wales and the north of England the lead veins are chiefly situated in the carboniferous limestone and rocks associated with it, especially in places where they are intersected and broken up by enormous faults and dislocations. Similar circumstances to these are very generally observed in all parts of the world, and it is also well ascertained that the local enrichment of veins is greatly influenced by their intersection with one another; and often indeed closely corresponds with the points of junction.

In addition to the general presumptions furnished by geological science, another and more precise indication of the existence of metalliferous deposits is afforded by finding pebbles or fragments of ore on or near the surface, generally either in the beds of streams or mixed up with superficial detritus. These scattered fragments, the result of diluvial action upon the outcrop of mineral veins or other deposits, may often be traced to particular spots, and thus the position of the deposits from which they originated may be established. In the north of England they are termed "shoad stones," and this mode of discovering veins is called "shoading." Should the exact situation of the vein whose existence has been ascertained in this or any other manner not be observable, it may be ascertained by opening trenches in the alluvial soil deep enough to expose the solid rock, their direction being at right angles to that in which analogy or the position of other veins in the neighbourhood would render it probable that the vein or veins in question might lie. This mode of finding veins is provincially termed in Cornwall "costeening." The object of discovery may be still more effectually attained, but at a greater expense, by excavating a nearly horizontal passage termed a "level," "drift," or "adit," from the bottom of the nearest valley, carrying it through the solid rock in the direction before mentioned, so as to intersect or "cut" any mineral deposit which may exist in the ground through which it passes. This last plan is however seldom adopted, unless it is previously well ascertained that mineral veins do actually exist there, as it is too slow and too expensive to be undertaken upon uncertain grounds. Discoveries are sometimes made also by driving on the course of veins which occur in cliffs or are exposed in the sides of brooks; trials of this kind fall within the compass of working miners or persons of very small capital, and in some instances form the first step in opening mines which ultimately become of great importance.

Although the manner in which mineral deposits may be and sometimes are originally discovered has been thus detailed, it must not be supposed that the process is one of very frequent occurrence. The principal mineral districts in this and most other countries have been known and explored for ages, and by far the greater part of our mineral produce is extracted from deposits which have long been worked, the principal new discoveries being either made upon untried portions of known veins, or simply by excavating passages or "cross-cuts" from mines now working, in a direction transverse to that of the vein upon which they are wrought, so as to prove the adjoining ground.

Financial arrangements, &c.—When however a new vein or mineral deposit has been by any process discovered, if the indications of metallic produce are such as to render it desirable to work it, the most usual step, after obtaining the consent of the proprietor, is the formation of a company for this purpose. For although mines are sometimes worked by individuals, experience has shown that a company is best adapted for carrying on mining operations, the amount of capital required being large and uncertain, and the risk great, while a long period may elapse before adequate returns are made. Hence, not only in England, but in most other countries, the system of working mines by companies has been adopted, being found decidedly advantageous. Certain stipulations are then entered into between the company and the proprietor of the land in which the vein or deposit is situated, or, should the mineral right not belong to him, with the person who does possess it. The principal terms of this agreement are to determine the extent of ground within which operations may be carried on, and to stipulate the proportion of the gross mineral produce or its equivalent in money which the owner is to receive free of all expense in raising and making it marketable. It often includes also compensation for damage done to the surface, and other considerations of less importance which are determined by the custom of the neighbourhood and other circumstances.

Before commencing operations, it is necessary to ascertain with some correctness (if it should not be previously known) the bearing or direction of the vein, and also its dip or "underlie," which may be done by sinking a few shallow pits upon it. These circumstances being known, there are two methods by which the vein may be explored, either by sinking upon its course from the surface, or by forming a horizontal passage to intersect it, commenced from some neighbouring valley or the lowest point on the surface which may be conveniently situated for the purpose; or both these modes may be carried on together if desirable. As, however, the practicability of forming a level or adit to prove the vein at a sufficient depth and within moderate limits as to time and expense must entirely depend on local circumstances, the former method, as being most expeditious, is generally resorted to, and is effected in the following manner.

Early Progress of the Works.—A spot determined either by convenience or by some promising indication is selected as the site of a shaft, which is frequently sunk in an inclined direction upon the course of the vein, or if intended to be perpendicular it is commenced upon that side towards which the vein inclines or underlies, and at such a distance from its "back" or outcrop as to come down upon it at a given depth, say 10, 20, or 30 fathoms. This depth is regulated by the means of the parties to prosecute the trial, and the depth at which analogy may lead them to suppose that ore in any quantity may be found, the superficial parts of veins being usually quite unproductive.

On cutting the vein the shaft is for a time suspended, and two horizontal passages, often termed "galleries," but by the miner "levels," are excavated or "driven" upon the vein in both directions. These passages are usually about six feet in height and three or four in breadth, and rather smaller above than below. They are the principal means of exploring the contents of veins, and are made larger or smaller according to their richness or poverty, their width, and the nature of the inclosing rock. Should the shaft be intended to cut the vein at any considerable depth, it may be desirable to explore it above the point of intersection, and this is done by driving a short transverse level or "cross-cut" to it, and driving two levels from the place where the "cross-cut" meets it, as before described. Should the depth of the shaft before reaching the vein be very considerable, two or three of these cross-cuts will be driven first, and levels extended from them. The perpendicular distance of the levels from each other is regulated both by custom and local circumstances, but is usually about 10 fathoms, that interval having been found most convenient for the objects of the miner.

After cutting the vein there are two modes of proceeding—continuing the shaft perpendicularly through the vein, or obliquely upon the vein. Which of these two plans is followed will depend in great measure upon its produce and promise, as already ascertained by the upper levels, and partly also on the means of the miner, the former plan being most expensive and requiring the longest time, although ultimately most advantageous, while the latter, though a cheaper and quicker mode of exploring the vein, since it renders cross-cuts unnecessary, and is itself continually proving one portion of it, is not well adapted for the application of pumps and machinery,—an evil which may not at first be very sensibly felt, but which increases proportionally with the depth of the mine and the quantity of water and stuff which require to be drawn from it.

Supposing the shaft to proceed perpendicularly after cutting the vein, on reaching the depth of 10 fathoms or thereabouts below the point of intersection another cross-cut will be driven to it; but as the shaft is now on the opposite side of the vein, this cross-cut will have an opposite direction to the former ones; and as they had successively become shorter as the shaft approached the vein, they will now successively become longer as the shaft, proceeding perpendicularly downwards, recedes further and further from the vein. In this manner the shaft proceeds indefinitely, cross-cuts being driven at every 10 fathoms or whatever distance is most convenient, and levels extended from each upon the course of the vein, the nature and value of which are thus thoroughly explored. The continuance of these and other operations necessarily supposes that ore in some quantity has been found in the upper levels, which will have been all this time in progress, or at any rate that the indications of future produce are sufficiently strong to encourage the miner to proceed with his undertaking, the magnitude and expense of which will now be daily increasing, while various difficulties will be encountered in the progress of his works, more especially the want of ventilation in those parts which are most distant from the shaft, by which alone they can be supplied with air. It is chiefly in the ends of the levels that the evil of imperfect ventilation begins to be felt, the air here gradually becoming close and unfit for respiration as they advance further from the shaft, especially when, from the hardness of the ground, frequent blasting is necessary. As soon as this is found to be the case a remedy of a very simple nature is applied, which consists in sinking a small pit, termed a "winze," *upon* the vein, of course, from the upper level to the extremity of the one below it. This communication having been effected, the two levels become perfectly ventilated, each having a double communication with the atmosphere, by which both an ascending and descending current is produced. By this plan it is evident that the levels may be extended for a considerable distance upon each side of the shaft, winzes being continually formed between them at convenient intervals. Besides the purpose of ventilation, these winzes answer another use, since they make trial of the vein in the intermediate space between two levels, and also divide it into solid rectangular masses, which may be examined all round, and thus the miner has the means of judging with tolerable certainty of the nature and value of the ores contained in each, and can extract the produce in the most expeditious and economical manner. That such is the case will at once be evident when it is considered that these portions of the vein are perfectly drained and ventilated, that they may be attacked at once from as many points as may be convenient or may contain ore of sufficient value, and from this circumstance no necessity exists for breaking down the unproductive masses which are often found to intervene even where the vein is richest and the ore most continuous. When the vein has been properly laid open, the ore may be worked away round such unproductive pieces of ground, which, being left standing, will answer the purpose of supports to the rock on each side of the vein. Where the excavations are extensive such support becomes extremely necessary, and often requires the use of strong timbering.

The utility of winzes for working out the ore is indeed so great, that it is only when little or no ore has been found in a level that it will have proceeded far enough for ventilation to become very defective, before a communication of this kind has been made. When, on the contrary, the ore is found to be tolerably continuous in driving a level, winzes are generally sunk at intervals of 20 or 30 fathoms, their position being so regulated as to prove the richest and most promising parts of the vein, and to avoid hard and unproductive portions which do not appear worth exploring. We will suppose, however, that a continuous body of ore is met with in one of the upper levels, and that winzes have been regularly carried down to the level below it. Similar operations will then be required here, and winzes will be sunk from it to the next deeper one in the same manner, but they will generally be situated about mid-way between the former, so that each may explore the ground under the middle of the rectangle formed by the two upper winzes and the levels between which they are placed, so as effectually to explore the vein with the smallest number of excavations. The system of works by which a vein is thus laid open, although by no means so regular, is not unlike the seams formed by courses of masonry, the horizontal joints of which may be supposed to represent the levels, and the vertical one the winzes. In cases where the ore extends above the upper level in the mine, this part of the vein may be laid open by perpendicular excavations similar to winzes, but formed in the reverse manner, or by "rising" upwards instead of "sinking" downwards, as in the former cases, the height to which these "rises" are carried depending on the extent of the ore in that direction.

Should the vein be found to contain ore of good quality and in sufficient quantity, both laterally and in depth, the various operations which have now been described may proceed indefinitely. The shaft will continue to be sunk, cross-cuts driven to the vein at every ten fathoms or thereabouts, levels extended in both directions from them (the upper level being always of course considerably more advanced than the lower, from having been longer in progress), and the ground between them subdivided by winzes as before described. The excavations will now have assumed a regular form, and become what is properly termed a mine, the objects for which they were undertaken having been accomplished, or the contents of the vein thoroughly explored, and its produce, where of sufficient value, rendered capable of being economically and expeditiously extracted. In the accompanying sketch, *Fig.* 1, the state of the works is shown, the shaded portion representing the parts of the mine whence the ore has been extracted as described below. *Fig.* 2 gives a cross section of the mine, and with the former will completely illustrate the foregoing description.

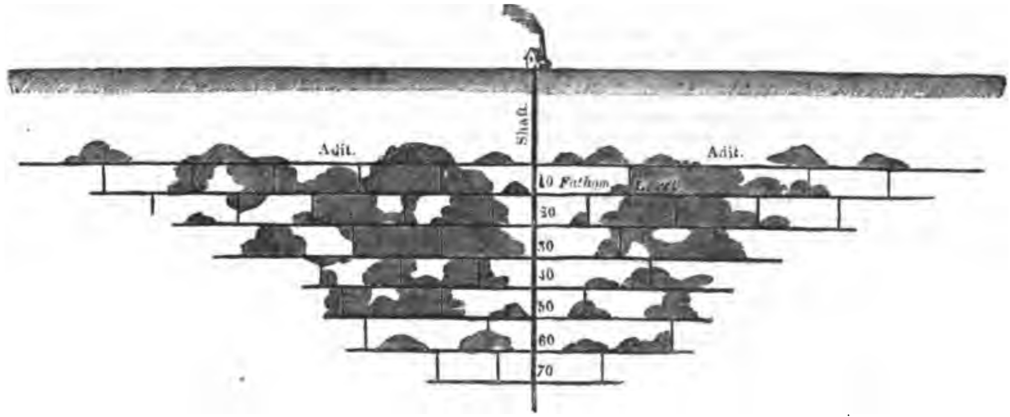


Fig. 1.—Longitudinal Section, showing the manner in which the vein is laid open by the level and winzes.

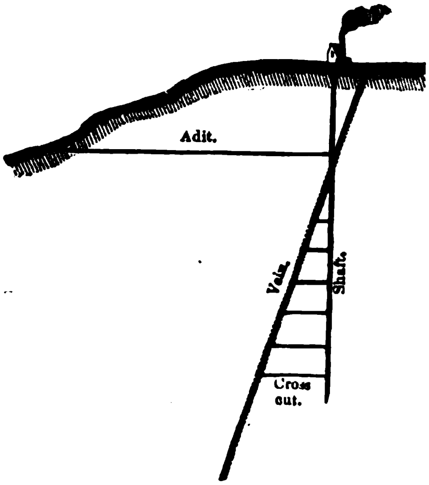


Fig. 2.—Cross Section, showing the progress of a shaft after cutting the vein.

Raising of Ore.—The operation last named, or the extraction of the ore, will not however have waited the advanced state of the works which we are now contemplating: a certain quantity will have been produced by driving the upper levels and sinking winzes below them, although not forming the primary object of these works; and wherever orey ground was seen in the "back" or upper part of the level first driven, it will early have been pursued upwards towards the surface, and will yield the first returns of the mine. When by the further progress of the works the vein has been divided into the solid rectangular masses before described, the mine will have been brought into an effective state of working, and parties of men will be set to raise ores from all the most productive points. Where the vein is not very hard, the ore may be broken down with the "pick" only, but it is generally necessary to blast it with powder, by which process large quantities are detached from the vein by every shot. In raising ores the men generally work upwards from the "back" or upper part of one level towards the "bottom" of another, and the excavations are so arranged that the ore may readily fall down to the level below them, whence it is carried in tram-waggons to the shaft, and thence raised to the surface. As in all large and well-regulated mines it is desirable to keep the quantity of ore raised as nearly as possible to a uniform standard, the process of "opening ground," as above described, will generally either keep pace with or even exceed the rate of exhaustion, so that a portion of the ore thus laid open may always be held as a reserve to keep up the returns of the mine during periods of temporary depression, when only poor and unproductive ground may be presented by the works of discovery. This judicious mode of proceeding is justly regarded as one of the greatest modern improvements in the economy of mining: it provides a compensation for those great irregularities and fluctuations to which all mineral deposits are continually subject; it keeps up the returns of the mine during temporary intervals of poverty, and enables those trials to be effected which may again place it in a productive state.

Extension of the Works.—As the workings of a mine become more extended, they gradually lose the simplicity which we have been supposing, and, from the multiplication of shafts and other excavations, become highly complex, a result to which the irregularity of mineral deposits greatly contributes. The nature of these ulterior operations will now be briefly described, still considering the mine as a mere system of excavations, and reserving till hereafter the subject of drainage, support, &c. When the levels have been extended to a considerable distance from the shaft, the ventilation will again become defective, notwithstanding their communication by winzes; the current of air, from the greater distance it is carried, becomes more and more feeble; and this evil is still further augmented by the increasing number of men now employed in the works, the number of candles, and the frequent process of blasting. The expense of the transport of ore and masses of rock and rubbish to the shaft also becomes considerable; and if the prospects of the mine continue such as to warrant the expense, a new shaft must now be sunk on one or both sides of the former. Whether one or two shafts will be necessary will depend on the direction in which the ore is found to extend, and the indications exhibited by the vein; and they will be so placed as to command that portion of it which, for reasons before stated, is without the reach of the former one, which by this time also may have become inadequate for the various purposes of extraction, drainage, and descent, to which it is applied.

In order to avoid the expense and delay of unnecessary cross-cuts, the new shaft will be so placed as to intersect the vein much deeper than the former, and this point will be so arranged as to correspond either with one of the deepest levels, or some proposed level deeper still. The new shaft may have been commenced in anticipation, while the levels were yet distant from the point where it is sunk; and in this case its communication with the mine will have been accelerated by driving levels to meet those which are proceeding from thence towards it. When this communication has been effected, its benefits will be immediately felt, both in the thorough ventilation of the mine and the increased facilities afforded for the extraction of ore and stuff.

As the process of sinking a shaft is often extremely slow, from the hardness of the ground (one fathom per week being a very good average, and sometimes half that progress being scarcely attainable), and as the most productive workings of a mine may be greatly impeded for want of another outlet to the surface, expedition is often of the utmost importance to remedy this evil, and it thus becomes highly desirable to accelerate the operation. The perfection which subterranean surveying has of late years attained enables the miner to accomplish this object by a very interesting process, whenever the workings of the mine have advanced near the spot where a shaft is required. The site of the shaft having been fixed upon and marked out at the surface, the miner, by a series of very accurate measurements of the length, windings, and direction of the levels, is enabled to ascertain correctly their relative position with regard to this spot, and consequently at what point each of them approaches nearest to a supposed vertical line penetrating the rock below it. This being ascertained, it is evident that by pursuing the same process still further, he may determine in what direction and to what distance cross-cuts must be driven from each of these points, in order to bring him exactly to this line, or underneath the site of the shaft; and having arrived there, that excavations exactly corresponding with it, both in form and dimensions, may proceed simultaneously both upwards and downwards from each cross-cut, while the shaft itself is being sunk from the surface, the work thus proceeding from several different points at the same time, as shown in *Fig.* 3. It is found in practice that the various separate portions may be made to unite with surprising exactness; so much so, that even in very deep shafts, when complete, daylight may be seen from the bottom; and from the great saving of time which the process effects, it is now frequently used in mines of great depth, the working of which is much facilitated by it, as the work of many years may thus be brought within the compass of one or two. A very remarkable instance of a deep shaft being thus sunk from several points at once occurred at the Consolidated Mines in Cornwall, about thirty years ago, where a perpendicular shaft, 204 fathoms in depth, was completed in less than a twelvemonth, being worked from fifteen different points at once.

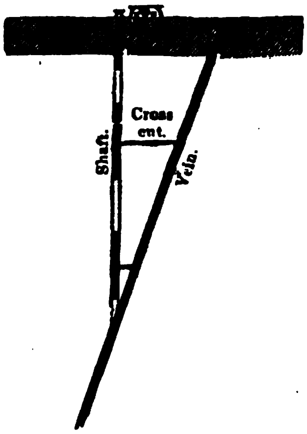


Fig. 3.—Cross Section, showing the progress of a shaft worked at several points.

As the working of a mine proceeds, the increase of shafts and levels tends to obliterate, in a great degree, the uniformity and simplicity of operations which were at first apparent, the position of these works being entirely regulated by the irregular distribution of the productive parts of the vein, as developed in their progress. When the depth becomes considerable, many of the first shafts are rendered in a great measure useless, either from being inclined, and thus inconvenient for machinery, or from having passed through the vein at a shallow depth, and thus requiring long cross-cuts previous to commencing the deeper levels. Hence, in very deep mines, a double line of shafts will often be found to range along the course of the principal veins; and sometimes even three shafts will be found opposite each other, and intersecting the same part of the vein successively at greater depths. In this case, while the most recent shafts are used for drainage and extraction, the older and more shallow ones are often fitted up as "footways," and serve for the partial ascent and descent of the miners. In some of the large mines of Cornwall it is usual to sink two shafts within a few fathoms of each other, one being of large dimensions, and intended for a drainage or "engine-shaft," the other smaller, and adapted to drawing stuff only. This arrangement is found more convenient than having a single large shaft arranged for both purposes, for which however one shaft is often made to answer, being divided down the middle by timbering, and one side appropriated to the pumps and ladders, while the other is occupied by the "kibbles" or iron buckets used for drawing the ore and in many cases the rubbish, when the latter cannot be conveniently disposed of underground.

Shafts in this country are generally sunk of a rectangular form, except in our coal mines, where a circular form is often preferred. Those intended for the extraction of ores, or "whim-shafts," are commonly six feet by four; those employed for drainage, or "engine-shafts," as they are generally termed, vary from about six feet by eight to eight by ten, or sometimes are rather larger. In coal-mines the pits are generally about seven or eight feet in diameter, the dimensions varying according to the nature of the ground and the arrangements proposed in them.

As veins are generally found to run nearly parallel, and often at no great distance from each other, and as the neighbourhood of a productive vein is a favourable indication of the contents of others in its vicinity, transverse levels or "cross-cuts" are frequently driven from mines at various depths, with a view to discovering side-veins, or making trial of branches which diverge from the main lode. Should a productive vein be found in the neighbourhood of the first, the most usual mode of working it is by extending levels upon it, at the same depth as those in the mine from which the cross-cuts are driven, commencing at the points where these intersect it. In this case the same shafts will probably serve for both the old mine and the new one, the one being, in fact, a mere appendage, as it were, to the other. Should the distance of the newly-discovered vein be considerable, it will prevent the workings from being carried on in this manner, both from the length of the cross-cuts, and from the difficulty of ventilation and extraction; and it will therefore be necessary to sink shafts upon it, and lay it open as a separate mine, in a somewhat similar manner to that which has already been described.

Metalliferous veins are often traversed by other veins crossing them nearly at right angles, which seldom contain ore, excepting perhaps near the points of intersection: they are termed "cross-courses," or "cross-veins," and occur in most mines. Cross-cuts are sometimes carried upon these veins, partly to explore their contents, and partly because the work will often proceed more rapidly than when in the solid rock; but this is not considered so effectual a mode of exploring the ground and discovering new veins as by driving in the rock itself.

The intersections of veins are very generally accompanied by a shifting and derangement of the metalliferous vein, the two portions of which on the opposite sides of the cross-vein, are often separated to a very considerable distance. As veins are most productive at or near the points where such intersections occur, the metalliferous mass on which the miner had previously been working is completely lost on coming to a cross-vein; and it is frequently a work of considerable difficulty to recover it again, as the productive vein may be thrown or "heaved" completely out of its former course. The first object to be ascertained, in the search for the dislocated vein, is in which direction the "heave" has taken place, whether to the right hand or the left; and from analogy the miner is generally, though not always, enabled to form a correct judgment on this head. He then continues the level upon the cross-vein in this direction, till the metalliferous vein is again met with on the opposite side, when the level is continued upon it as before. If the search should be continued for a long distance without success, he will drive in the other direction, in expectation of meeting with it there.

Adits.—Where a vein has been worked by driving a level towards it from a valley or other convenient point on the surface, the drainage to the point of intersection is, of course, complete; and hence in mountainous countries, where deep ravines occur, levels may be brought in one below another, so as to prove the veins and unwater the mines to a considerable depth, almost superseding the use of machinery for this purpose. Levels thus opening to the surface, and serving for drainage, are termed "day-levels" or "adits," and few mines are without one. In cases where mines have been opened by sinking down from the surface, which is the most common method, an adit is generally commenced from the bottom of some neighbouring valley (see *Fig.* 2), which is driven towards the vein with a slight inclination, so that the water may readily flow through it; and in large mining districts adits have been formed of enormous length, traversing a considerable number of mines, and carrying off the water to the lowest practicable point of drainage. In driving an adit, if the length be considerable before it reaches the mine which it is intended to drain, the distance is often divided into two or more portions by sinking shafts upon its course, and driving from the bottom of each on reaching the requisite depth. The work is thus expedited in proportion to the number of points from which operations may be commenced. Adits may often be made valuable as works of discovery, by making them cross the direction of the veins occurring in the district, so as to intersect them in their course, when they afford the means of trial at a cheap rate, by driving upon them at the points of intersection. In some cases adits may be carried almost entirely upon veins, to which they thus afford an important trial.

It is evident that the shafts and levels may be indefinitely extended in the manner which has now been pointed out, and should the produce of the mine be considerable, the portions of the vein successively laid open continue productive, and other veins be discovered by cross-cutting in its vicinity, this extension of the works may be continued for many years. Thus, in the course of time, from a few simple excavations, we obtain that almost infinite complication of shafts, levels, cross-cuts, and other workings, which characterise the workings of an extensive mine, with all its numerous appendages of pumps, machinery, and buildings.

The operations which have now been described are applicable to all large and regular metalliferous veins situated in countries where no distinct stratification exists, and where, therefore, from the homogeneous nature of the rock, the metallic produce may extend to very considerable depths without any great fluctuation. The mining districts of Cornwall, and those of Germany and Mexico, are chiefly of this class.

Mining in Stratified Districts.—In working mineral veins in distinctly stratified countries, this geological feature has a great influence on the arrangement of the subterranean works, as it impresses a peculiar character upon the contents of the veins, the metalliferous portions of which are in great measure confined to certain strata, while the intervening parts are poor and unproductive. Thus, instead of exploring the whole mass of the vein, as in the former case, it is only necessary to lay open those limited zones which are embosomed in the strata most favourable to enrichment, and to which therefore the workings are chiefly confined. The lead-mines of North Wales, of Derbyshire, and of the North of England, are worked in the carboniferous limestone, and the grits and shales resting upon it, the two former being the productive rocks. In these mines therefore the mode of working above noticed is adopted, and, from the abrupt and mountainous nature of the country, great facility is afforded in carrying on the subterranean works, which are generally executed in the following manner. A point is selected in some valley or ravine where the edges of the strata are exposed to view, and from thence a level is commenced, if practicable, upon the vein itself, and in one of the beds known to be favourable to its enrichment, the progress of which effectually explores its produce, and admits of a convenient extraction of the ore. Should the vein itself not appear in any spot from which it can be directly driven upon, the level is driven as a cross-cut till it is reached, being either carried on one of the productive strata, or in some other bed adjoining them which may afford greater facilities for driving. Whenever bunches of ore are found in the progress of this level upon the vein, excavations are carried upwards and downwards into them, as far as the ore extends, thus laying it open in a convenient manner for extraction. Should the ore extend far enough towards the surface to render it necessary, levels may be driven from the "rises" to render it more accessible, and should another productive stratum be situated at no great height above the first, similar operations will be extended into that also. The vein having thus been laid open, the masses of ore are placed in a proper state for working; they are broken from the vein either by the pick or by blasting, and the works so arranged that the stuff falls at once into the level below, whence it is transported in tram-waggons to the entrance, near which the dressing-floors are usually placed. *Fig.* 4 represents the section of a mine worked in the above manner.

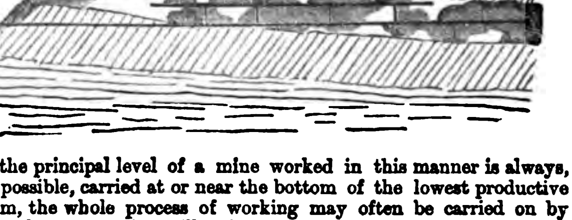


Fig. 4.

As the principal level of a mine worked in this manner is always, when possible, carried at or near the bottom of the lowest productive stratum, the whole process of working may often be carried on by rises, and no necessity will exist for sinking below the main level, which answers the purposes both of drainage and extraction. When, however, other productive strata exist below this, which from the nature of the country are inaccessible by day levels, recourse must be had to sinking winzes below it to explore them.

When a level has been driven a considerable distance from its mouth or entrance, a shaft will be required, which is usually sunk from the surface so as to come down upon it near the end. The deeper workings are then carried on by means of this shaft, which is either continued perpendicularly or upon the vein, till it reaches the next productive stratum, upon which a level will be driven. By extending the day level or adit upon the course of the principal vein, and such others as may be found in its vicinity, and by sinking shafts occasionally where they may be found necessary; a mine worked in this manner may be indefinitely extended, and its workings arranged so as to be accommodated to the nature of the metalliferous deposits which may be discovered in their progress.

Although the general principles which regulate the direction of mining operations will best be understood from thus tracing their most important modification from the beginning to a mature and systematic development, it must not be supposed that all mines are invariably worked upon the same plan, or even that the first opening of mines is a thing of very frequent occurrence. The local circumstances of mines are so exceedingly various, and the irregularity and complexity of mineral deposits so great, that a corresponding diversity must exist in the means adapted for exploring them, and hence, although the general principles and features are the same in all, no two mines will be exactly alike, nor would the same unvarying processes be suitable for them.

Mining Tools and Processes.—The tools and processes employed by the miner in the excavation of the rock or the vein are simple, and will require only a brief notice. As his work is chiefly of two kinds, simply *excavating* the ground when soft, and *blasting* it when hard, his tools are suited to each process, the "pick" and "gad" being used for the former; the "borer" or "jumper," and the "hammer" used to propel it, for the latter, with several minor accessories for firing the shots, when the hole has been completed to its proper depth. The *pick* is a very useful tool and much employed by the miner both in working in the rock and in breaking down ore where the ground is not so hard as to require blasting. It resembles a common pickaxe, but is smaller and more convenient, the iron head being sharp and pointed at one end, and very short and hammer-shaped at the other, a form which peculiarly adapts it to underground uses. The *wedge* or "gad" is sometimes used in conjunction with the pick; it is made of wrought-iron, and often with curved sides. The *borer* or "jumper" is an iron rod or circular bar usually about two feet in length, steeled and formed into a flat sharp edge at the end; it is driven into the rock by one man with a heavy hammer, while the other continually turns it round so as to expose the cutting edge to fresh surfaces of rock. The pulverised matter is drawn out from time to time by a tool called a "scraper," and when the hole has proceeded to a sufficient depth, and been charged with powder, an iron wire with a copper point, or, what is still better, a piece of copper wire, with a loop at the end, is introduced, when the charge having been firmly rammed down with clay or other soft mineral substance, the wire or "needle" is withdrawn, and a train of gunpowder inserted in its place. The train is then fired by a slow match (often a piece of brown paper smeared with grease), and the miners retire till the explosion has taken place. A very ingenious contrivance for firing the charge was invented some years ago in Cornwall, by Messrs. Bickford, called the "safety fuse," which is now getting into very general use in our mining districts. The safety fuse consists of a small train of powder inserted in a water-proof cord, and being cut to the required length, regulates the time of the explosion by its known and steady rate of ignition. The use of this contrivance and the substitution of copper for iron in the "needle," have contributed of late years to prevent the accidents arising from premature explosion, which were formerly of very common occurrence in mines.

Auxiliary operations.—Having now considered mining in the most simple point of view which the subject admits—as the arrangement of a system of subterranean works adapted to effect the great objects of discovery, extraction, ventilation, and drainage, it remains to notice the various auxiliary operations which the progress of these works will have required, and the complicated machinery which will thus have been called into action, both on the surface and underground. The auxiliary works in question will have been directed towards two distinct objects, one portion of them being subsidiary to the actual working of the mine itself, and the other directed to the mechanical preparation of the ores extracted, so as to render them fit for the smelting works, to which they are finally consigned for reduction, this last process being sometimes carried on upon the spot and by the same parties, and in other cases being performed at a distance by a distinct agency. We now proceed to consider the former of these two classes.

The underground works of a mine will not have proceeded far before it becomes necessary to provide for several very important contingencies; water filters rapidly in, and, excepting where mines are worked by day levels or adits (or even then on sinking below them), requires some power to be provided for drawing it out; excavations are formed which require support; ventilation in places requires to be aided by mechanical means; and lastly, the continually increasing extraction of ore and rubbish renders powerful and efficient means indispensable for its discharge.

Drainage; Horse-Whim.—The drainage of a mine is one of the earliest things which it becomes necessary to provide for, as mineral veins are generally more open and porous than the surrounding rock, and thus form natural reservoirs into which the surface water collects. When penetrated by the workings of a mine, this natural drainage is rendered still more complete, and water pours abundantly into the excavations. The most obvious mode of relief, where local circumstances are favourable, is of course the formation of an adit, but excepting in very abrupt and mountainous countries, where this work can be readily executed, mechanical power soon becomes necessary. This may be in the first place afforded merely by a "horse-whim," which will serve to raise both the water and the stuff broken in sinking; and in Mexico, before English skill and capital were applied to the working of the mines, this simple apparatus was the only power used in their drainage and extraction. Its application on the large scale is however so enormously expensive, so complicated, and so inconvenient, that in the mines of Europe it is only used upon a limited plan, and mechanical power is substituted as soon as possible for animal labour. The machine alluded to consists of an upright shaft carrying a large cylindrical cage or drum, and turned round by a long lever, to which the horses are attached. A rope is coiled round the cage of the whim, with both ends at liberty, so that while one end is winding up, the other is unwinding, and both pass over a pulley placed above the shaft, having large iron buckets or kibbles attached to them, which by this arrangement are kept alternately ascending and descending, one kibble being loaded at the bottom while the other is emptied at the surface. This apparatus is termed a "whim" in Cornwall, but in the north of England a "whimsey" or "gin." Where mines are not very deep it is a convenient auxiliary in the extraction, but is only useful for drainage when the quantity of water is very trifling, as in sinking a mere trial shaft. (See *Fig.* 5.)

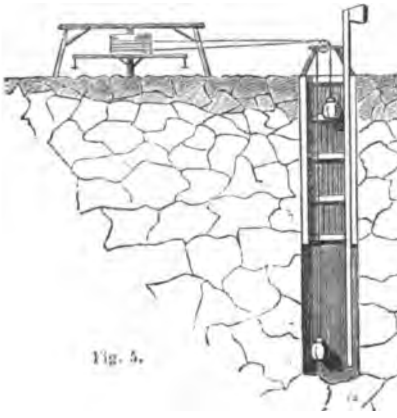
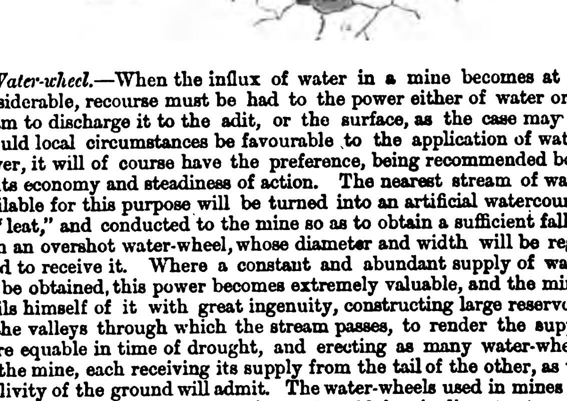


Fig. 5.

Water-wheel.—When the influx of water in a mine becomes at all considerable, recourse must be had to the power either of water or of steam to discharge it to the adit, or the surface, as the case may be. Should local circumstances be favourable to the application of water-power, it will of course have the preference, being recommended both by its economy and steadiness of action. The nearest stream of water available for this purpose will be turned into an artificial watercourse, or "leat," and conducted to the mine so as to obtain a sufficient fall to turn an overshot water-wheel, whose diameter and width will be regulated to receive it. Where a constant and abundant supply of water can be obtained, this power becomes extremely valuable, and the miner avails himself of it with great ingenuity, constructing large reservoirs in the valleys through which the stream passes, to render the supply more equable in time of drought, and erecting as many water-wheels on the mine, each receiving its supply from the tail of the other, as the declivity of the ground will admit. The water-wheels used in mines are invariably overshot; they vary from 10 or 12 feet in diameter to more than 50 feet, and from 2 or 3 to 6 or 7 feet in breast: some of the largest exceed 100 horse-power. The German miners have long been celebrated for their skilful application of water-power which, from the mountainous nature of their mining districts, early presented itself to their notice. In this country, from the general application of the steam-engine to the drainage of mines, water-power has been less cultivated; but many fine instances of its use may be seen in some of our mines, where circumstances have been favourable to its adoption. Among these may be named the Fowey Consols Mines in Cornwall, the mines of Wheal Friendship and Wheal Betsy in Devonshire, and of Grassington in Yorkshire. The application of a water-wheel to the drainage of a mine is shown in *Fig.* 6.

Fig. 6.



Pumps.—During the erection of the water-wheel pumps are fixed in the shaft, proportioned in size to the quantity of water to be drawn, 10 or 12 inches in diameter being a very common size, where there is only a moderate influx. The pumps used in mines do not act at all by atmospheric pressure, as in the case of the common household pumps; they are arranged in "lifts," or columns, of considerable height, often indeed from 20 to 30 fathoms, the water being discharged into cisterns placed at the foot of each, and raised entirely by lifting or by pressure. The construction and arrangement of the pump-work forms a very important branch of mining, and one which, from the great depth of our mines, and the vast influx of water so common in them, has been much cultivated in this country, and consequently brought to great perfection. Wooden pumps were formerly common in mines; but they have for a long while been entirely superseded by iron ones, which admit of the lifts being carried to a great height without leaking, or the danger of bursting. The whole column of pumps in a shaft is commonly worked by a single pump-rod, which goes down the middle of it and communicates with each column by a rod attached to its side. In order to give a reciprocating motion to the main pump rod, a crank on the axle of the water-wheel is attached to one end of a horizontal rod, the other end of which is fixed to an apparatus termed a "bob," consisting of an upright post moveable on a centre, and firmly braced to a horizontal piece framed into it at the bottom, the further end of which is connected with the pump-rod. In this manner it will be seen that the rotatory motion of the water-wheel is converted into a steady reciprocating motion when communicated to the pump-rod, the weight of which is always counterbalanced by a large box filled with stones, old iron, &c., which is attached to the opposite end of the balance-bob. (See *Fig.* 6.)

As the power of the water-wheels used in mines is entirely due to the gravity of the water, or the force it exerts in falling through a given space, minus the effects of friction, it is only where a considerable stream can be obtained that water-wheels of sufficient power can be erected; but in cases where the supply of water is very limited, and it is practicable to obtain a considerable fall, there is another very ingenious mode of applying it, by which the principle of hydrostatic pressure is called into action. This contrivance is termed the "water-pressure engine," and is a good deal used in the German mines, though only to a limited extent in this country. The principle consists in giving motion to a piston by the alternate pressure of a high column of water, which having performed its office, the communication is cut off, and the water in the cylinder escapes. The apparatus is not in fact unlike the working portion of a steam-engine, the hydrostatic pressure of a column of water being substituted for the force of elastic vapour, and the reciprocating motion thus produced may be directly applied to set the pumps of a mine in action.

Steam-engine.—From the great abundance of coal which exists in this country, and the cheap rate at which it can be generally obtained, the steam-engine has long been the great auxiliary of the English miner, and in its present improved state it has greatly contributed, as before noticed, both to the perfection of our mining system and the enormous extraction of minerals and metallic substances by which our mines are distinguished. In our coal-mines, where the fuel is of scarcely more than nominal value, the steam-engine is the only power ever employed for drainage, and in all deep and extensive works for extraction also. In our copper, tin, and lead mines, on the contrary, where the carriage of coal renders the use of it more expensive, water-power is always, as far as possible, rendered available. In all the deepest and most extensive mines of this description the steam-engine is however indispensable, and both the drainage and extraction have been in great measure performed by it, since its use has been so greatly economised by the reduced consumption of coal consequent upon late improvements.

The history and progressive improvements of the steam-engine are so intimately connected with its general application to mining purposes, and consequently with the present perfection which the art of mining has attained, and the vast produce afforded by our mines, that it requires some brief notice here. The efficiency of a steam-engine for mining purposes is estimated in Cornwall (where from the great expense of coal, all the late improvements have originated) by the standard termed *duty*, which accurately and conveniently defines the work performed, with reference to the consumption of a given quantity of coal. Thus, by the duty of an engine is expressed the number of pounds (always millions) of water which have been raised through the height of one foot by the consumption of a bushel of coal, the data for this calculation being the quantity of water discharged from the pumps in a given time, and the quantity of coal consumed by the engine in the same period. This mode of calculating the efficiency of steam-engines was practised by Watt, who thus estimated the saving of fuel effected by his engine compared with the atmospheric engine previously in use, one-third of this saving being the remuneration claimed by him for the use of his invention. An admirable system for the registration of the duty and other peculiarities of the engines employed in Cornwall was organised in the year 1813, and this system has been ever since continued, the results being monthly ascertained and published in a convenient form. The effect of this system has been to excite an extraordinary degree of competition among the engineers, each of whom strives to improve the duty of his engines in every possible manner. The improvements which thus resulted were so unexpected and so extraordinary as to excite suspicion and incredulity among those engineers who resided in other parts of England, which have only been removed by the most rigorous scrutiny and experiments.

The progressive improvement of the duty of steam-engines has been very accurately traced by Mr. John Taylor, in his 'Records of Mining;' and the following is a summary of the results which he obtained :—

In 1769	the old atmospheric engine, by consuming a bushel of coals, raised . . .	5,500,000	lbs., 1 foot high.
„ 1772	as improved by Smeaton .	9,500,000	„
From 1778 to 1815	the steam-engine as improved by Watt . .	20,000,000	„
„ 1820	as improved by the Cornish engineers	28,000,000	„
„ 1826	„ „	30,000,000	„
„ 1827	„ „	32,000,000	„
„ 1828	„ „	37,000,000	„
„ 1829	„ „	41,000,000	„
„ 1830	„ „	43,350,000	„
„ 1859	„ about	54,000,000	„

The above statement, it should be observed, refers only to the average duty, many of the best engines having always greatly exceeded this; and at the present time the duty of the best engines in Cornwall varies from about sixty to eighty millions. In the latter case therefore one bushel of coal performs as much work as fifteen bushels effected seventy years ago, or as was accomplished by four till within the last five-and-forty years. When it is stated that some of the most powerful engines in Cornwall consume from three to four thousand bushels of coal per month, that some mines employ several such engines, and that the mere expense of drainage is 12,000*l.* or 13,000*l.* per annum, the importance of the improvements above noticed will at once be appreciated.

Independently of the vast and practically unlimited power which the steam-engine places at our command, it may be considered as universal in its application, and entirely unrestricted by those limitations of local circumstances which circumscribe the utility of all other modes of drainage. The steam-engine may be erected on any spot which convenience requires, and it may be made of whatever degree of power may be considered requisite; fuel and water alone are needed for its operations; and while successive improvements have reduced the former to a fraction of its earlier consumption, it can always supply itself with the latter from the ground. This independence of local circumstances is of the more importance to the miner, as it is not in his power to make choice of localities: the manufacturer may erect his mill wherever water-power is abundant for driving his machinery, but the miner must carry on his operations on whatever spot nature has deposited her mineral treasures, and make the best of circumstances over which he can have no control. Thus the steam-engine smokes in the narrow valleys of Cornwall, almost at the sea-level, on the verge of the cliff at Botallack, and on the elevated table-land of Mexico.

The steam-engines employed for drainage are erected close to the shaft in which the pumps are fixed, which is called the "engine-shaft;" one end of the beam hangs over the centre of it, and is attached to the pump-rod, which is raised at each stroke of the engine, afterwards sinking with its own weight, which is always counterbalanced by a "balance-bob," as before explained, so that the whole power of the engine is exerted in raising the column of water in the pumps. The engine is generally enclosed in a large substantial building, either two or three stories high, which affords convenient access to every part of it. The centre of the beam is supported by the front wall of the house, and a low building attached to it contains the boilers, which in Cornwall, together with the steam-pipe and cylinder, are carefully cased and covered up with some non-conducting substances. The arrangement of the engine, with that of the "capstan" and "shears" used in raising and lowering the pit work, is shown in *Fig. 7.* The engines employed in draining mines have generally cylinders of not less than 40 inches in diameter, and the cylinders vary from that size to a diameter of 80 or 90 inches, the latter being the largest size ever constructed, and estimated at 300 horse-power. The chief peculiarities of the Cornish engines consist in using high-pressure steam (40 or 50 lbs. to the square inch) expansively, by cutting off the communication with the boiler at one-fourth or one-fifth of the stroke; in allowing a short interval between each stroke for the perfect condensation of the steam, and in carefully preventing the radiation of heat from the boiler, cylinder, &c. The engines employed in our collieries present no peculiarity worthy of notice, nor has any great attention been paid to their improvement, owing to the cheap rate at which they can be supplied with fuel.

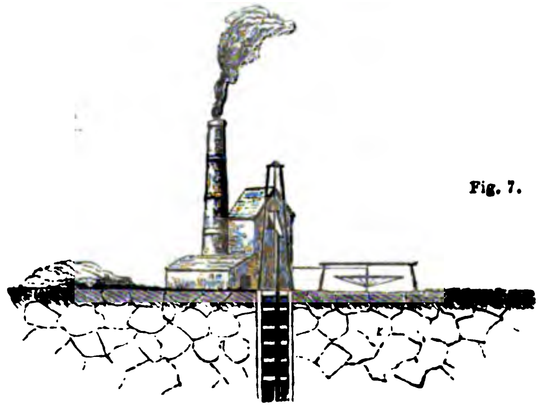
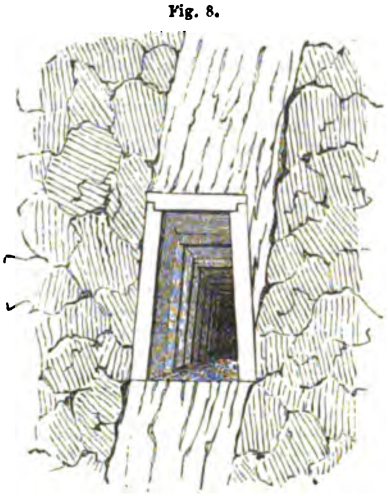


Fig. 7.

Support.—The support of mines is the next subject which requires our attention, and the extent to which it is necessary will depend very much on the nature of the inclosing rock, which may be either so hard as to stand of itself, or so soft as to crush together unless the excavations be properly secured. The mode of support used in mines is of three kinds: by leaving pillars of the vein, as before noticed, for which purpose the poorer masses are of course selected; by timbering; and by walling either with brick or stone. Timbering is a very common and convenient plan, and is thus practised:—In the case of a shaft, four pieces of timber of the requisite strength are framed into each other and fixed within it at intervals of about four feet apart, the intermediate ground being supported by driving thin boards between each set of timbers and the rock. Levels are supported by three pieces of timber placed in the form of a doorway, rather narrower above than below, and framed together at the top (see *Fig.* 8), the ground between each of these doorways being supported in the manner above noticed. Shafts and levels are sometimes also supported by walling, and in coal-mines the pits are generally lined throughout with brickwork. The "gunnies," or large open excavations from which the ore has been taken, are kept open by strong pieces of timber placed across them, and pressing against the two walls of the vein, which they thus prevent from closing together, as might otherwise be the case, especially where the vein was much inclined, and the pressure of the unsupported hanging wall is consequently great. These open spaces are very useful for disposing of the deads and rubbish which are continually accumulating underground when the workings are carried on in the rock or in unproductive parts of the vein, and which it would be useless and expensive to raise to the surface. For this purpose a "stull" is formed by placing strong timbers in the backs of the levels, upon which boards are laid, so as to form a close covering on which the deads and attle (or rubbish) are then thrown, till the space above has been completely filled up. The pressure of this mass gives it sufficient solidity to support the walls of the vein in an effectual manner; but notwithstanding the large quantity of rubbish thus disposed of in mines, a great deal always remains to be taken to the surface, as the waste heaps on the surface of every mine will show.

Fig. 8.



Ventilation.—The ventilation of mines is more generally and more effectually accomplished by a judicious arrangement of the works and frequent communication with the surface than by mechanical means, although it sometimes becomes necessary to resort to the latter. It will be evident that in mines constructed on the principles which have previously been explained, the disposition of the shafts, levels, and winzes is such that the entire workings will always be traversed by currents of fresh air, and it is only in particular cases where circumstances prevent the sinking of a shaft in places where it may be required, or where great delay is experienced in effecting the usual communications, that any mechanical process of ventilation is rendered necessary. A very efficient machine for this purpose was invented some years ago by Mr. John Taylor. It consists of a cylindrical exhausting apparatus, which may be fixed at the mouth of a shaft or level, and placed in action by any convenient power, when, by means of a series of tubes connected with it, the foul air is extracted from the interior of the works, and of course the pure atmospheric air rushes in to supply its place, and complete ventilation is thus effected. In sinking shafts, a very simple contrivance is often found sufficient;

small wooden pipes made tolerably air-tight are fixed in the pit from near the bottom to six or seven feet above the top, terminating in a funnel-shaped wooden box, which is moved round so as always to face the wind. The air rushing in passes down the pipes to the bottom of the shaft, in which a constant current is thus kept up (see *Fig. 5*). When levels have to be carried to any great distance without any communication with the atmosphere, they are sometimes divided by a "sollar," or wooden platform placed a foot or two above the bottom, and in this manner a sufficient current of air is obtained to enable the miners to proceed. In the north of England a contrivance called the "water blast" is often used in driving long levels into rising ground; it consists in putting down either a bore-hole or small shaft near the end of the level, and turning a small stream of water into it, which falls into a cistern placed at the bottom, and is found to carry with it a sufficient current of air to ventilate the works. In coal-mines the ventilation is much more difficult, and, from the rapid generation of explosive gases, more important also. It is generally effected by two shafts, one of which is called the "downcast" and the other the "upcast" shaft, the latter of which occupies the highest situation with reference to the dip of the coal, and has a large furnace continually burning near the bottom of it. The air being considerably rarefied at this point, an ascending current is formed, which passes upwards to the surface through the upcast shaft with considerable velocity, causing a descending current to pass through the downcast shaft to supply its place, and by a very ingenious arrangement of the workings this current of pure atmospheric air is made to traverse every part of the mine in succession as it passes from one shaft to the other.

Extraction.—The extraction of the materials from mines will require but little notice here, since it may be stated in general terms merely to require the adaptation of an efficient prime mover to any convenient form of winding apparatus: a purpose for which the steam-engine is very usually employed, although where water-power can be obtained it is equally effective. The horse-whim, or gin, as already noticed, is very useful in small mines or isolated workings, and before the introduction of more powerful machinery was very extensively employed for raising ore and stuff from our mines. In shallow preliminary excavations the common windlass is often employed, and in underground work is much used for various purposes, especially in sinking winzes, and raising the stuff from workings where no regular communications have been opened. The extraction of an extensive mine is enormous: indeed the quantity of ore raised is seldom more than one-third or one-fourth, sometimes indeed a fifth, or less, of the mass of stuff which is brought to the surface. At the Consolidated Mines in Cornwall, the daily extraction is about 200 tons, a large proportion of which is raised from a depth of from 200 to nearly 300 fathoms. In the coal-mines in the north of England the extraction is still greater; but here nearly the whole of the mass raised is more or less valuable, coal-mines being much less incumbered with dead or unproductive works than those of the metals. The South Hetton Colliery, in Durham, sends about 600 tons of coal "to bank" daily, and is capable of affording a much larger extraction.

Mechanical Preparation of Ores, or Dressing.—Having now traced the nature and progress of those subterranean works by which access is obtained to mineral and metalliferous deposits, and their produce extracted, we may briefly glance at the mechanical processes of separation, technically termed "dressing," which fall within the province of the miner, and to the carrying on of which a large portion of the surface-works of every mine is devoted. The object of dressing is to separate as far as possible the earthy matter accompanying, and, as before noticed, often mixed up with the ores, from the metallic portion, which is alone valuable; and the great principle upon which all the varied apparatus and processes which are used in different mines, and in different countries, to effect this purpose, entirely depend, is the difference in specific gravity between earthy and metallic matter, the one being generally double that of the other.

The dressing-floors of a mine are always arranged as near the mouths of the principal shafts and levels as possible, the ore being conveyed to them by a small railway; and they are always provided with an adequate supply of water by an artificial channel or "leat." The floor itself is paved, and there are on one or two sides ranges of sheds for the persons employed to work in, and buildings containing the apparatus used in the operation, which commences by picking the ore, which is brought from the mine in large irregular lumps, as blasted or broken from the vein. These lumps, of which more than half is often merely spar and veinstone, are broken into smaller pieces with hammers, an operation commonly performed by boys and young women, when a good deal of the sparry matter is picked out by hand and at once rejected: the residue is moderate-sized pieces of ore, more or less mixed with veinstone, and often nearly free from it. From rich veins a large proportion of the ore is obtained in a very pure state, and in this case it is only necessary to break down the large irregular masses into small fragments of a pretty equal size, in order to render it marketable and fit for the furnace, there being no earthy or sparry matter to separate from it. This rich ore is immediately therefore arranged in circular heaps upon the dressing-floors, containing a certain number of tons each, commonly fifteen or twenty, and in this state it has much the appearance of fine metallic gravel. The poorer class of ores, after being broken by hammers, and partially separated from the matrix by picking, have still a great variety of manipulations to undergo, which depend on the nature of the metal and the quality of the ore itself. Of these processes it will be sufficient here to notice three, "crushing" or "grinding," "jigging," and "stamping," each of which is performed by an appropriate machine. The crushing-mill, or grinder, consists of one or more pairs of iron rollers, placed within a very short distance apart, and kept in motion either by the direct action of a water-wheel or by cog-wheels attached to it. Immediately above the rollers is a hopper, into which the lumps of poorer ore are thrown, when, falling through between the rollers, they are completely crushed into small fragments. In some crushing-mills there are two or three pairs of rollers, those below being placed very near together, so as to reduce the stuff falling from above still finer, and by an ingenious application of sieves, kept in motion by the machine, the stuff can be sorted into two or three different sizes. Although by passing through the crushing-mill the ore, with its accompanying veinstone, has been reduced to very small fragments, the two substances are still as completely intermixed as ever; but in the next process, by the jigging-machine, or "brake-sieve," they are, to a considerable extent, separated. This machine consists of a wooden frame, open at the top, and provided with a strong screen, or iron grating, at the bottom: it hangs over a cistern of water, being suspended to a long lever, the motion of which alternately plunges it into the water and raises it out, with a peculiar jerk each time. The ores being placed in the sieve, and subjected for a short time to this operation, the heavy metallic pieces settle at the bottom, while the lighter fragments of spar and veinstone are thrown to the top, and every now and then very dexterously skimmed off with a piece of board by a man who stands by. In the operation of jigging, a very important separation is thus effected, as three products are obtained by it—the small rich particles of ore, which pass through the sieve into the cistern below, and are removed occasionally, as may be necessary; the larger rich fragments, which occupy the bottom of the cistern; and the poor earthy matter, which forms a layer at the top. This last product, although poor, still contains too much metal to be lost: it consists of small fragments of rock or veinstone, many of which have small particles of ore either attached to them or intermixed with them, and, to any eye but that of the miner's, would appear quite worthless, no less from the small quantity of the ore than the manifest difficulty of separating it from such a mass of stony matter. To extract the ore from this refuse matter, several processes are used, which are chiefly grinding between rollers placed very close to each other, stamping to a fine powder by the stamping-mill, and finally, washing upon an inclined plane. In this operation the fine metallic mud or "slime," being carefully spread over the inclined plane at the upper end, a gentle stream of water is allowed to flow over it, which washes the light earthy particles towards the bottom, leaving the heavier metallic ones in a very pure state towards the top. As in this process, and indeed all other operations of dressing in which a stream of water is employed, many of the smallest and most minute particles of the ore are carried away by it, the waste of which, in an extensive mine, would be considerable, it is arranged that all such water shall pass into successive reservoirs, termed "slime-pits," in which the metallic particles fall to the bottom, and are from time to time collected and subjected to such treatment as to obtain them in a tolerably pure state, as a good deal of earthy slime is always deposited with them.

It will be seen from the preceding notice that by repeated pulverisation, washing, and agitation, the metallic ores may be obtained at length in a very pure state, the earthy matter with which they were originally intermixed being by these processes almost entirely separated from them. When subsequently placed in the furnace, this residual earthy matter becomes fused together with limestone, used as a flux, and forms the vitrified matter termed "slag;" while by continued heat, the sulphur, oxygen, and other mineralising substances, which are in a state of chemical combination with the metal, are entirely driven off, and the latter obtained in a pure state. These operations constitute the process of metallurgy.

Variations of the Process.—Any further detail on the subject of dressing would here be out of place; yet it is necessary to observe that different ores require different processes, and that the general outline indicated above is thus subject to considerable modification. In the case of tin ore, which is very intimately disseminated in the rock or veinstone, a very minute pulverisation is required: hence stamping is most extensively practised in our tin-mines; and as the ores of this metal may be dressed so as to give a produce of 50 or 60 per cent., very great attention is paid to this point, and the various manipulations are carried on with a greater degree of attention than in the case of other metals. In the case of copper ores stamping is less used, but jigging forms a very important process, and has consequently undergone great improvements of late years, having given rise to a very ingenious and useful invention, called the "patent separator," in which the sieve is stationary, but the water kept in motion. This contrivance was invented by Mr. Thomas Petherick, manager of the Fowey Consols Mines in Cornwall, where it was successfully brought into operation. The ores of the precious metals require also a peculiar treatment, being generally in a state of minute subdivision, and mixed up with a vast mass of earthy matter. Gold ores are usually stamped, and silver ores ground to an exceedingly fine powder; but from the great value of the metals, the process of washing is carried on differently from that of others, and, in some cases, is dispensed with altogether.

Management and Internal Economy of Mines.—Having now taken a general view of mining operations, and the auxiliary processes which they require, there is still an important branch of the subject which requires some notice, the management and internal economy of mines. As it is on the due regulation of this point that the success of mines in a very great degree depends, it has, both in this and other countries, received great attention, and been reduced to a system as perfect as possible. In England, more especially, all the practical improvements suggested by experience as essential to the profitable and well-regulated existence of large mining establishments have been freely adopted, as we are here unfettered by those formalities and restraints which influence the continental systems, individual interest being allowed unlimited scope. The nature and importance of the subject now under consideration cannot be better expressed than in the words of a gentleman of the highest eminence as a mining-engineer, Mr. John Taylor, who has thus treated it, in connection with late mechanical improvements in the art of mining:—

"Important as the improvements are which we have contemplated in the instruments which the progress of physical science has placed in our hands, those which relate to the government of large bodies of workmen, to the inducement to active enterprise on the part of the labouring miners, to the removal of difficulties in their way, or of placing them in circumstances most favourable to effective exertion, are even more important, and to this may be added the judicious application of those very inventions which have been noticed. It must be recollected that, after all, the great expenditure in mining is for manual labour, and that we have no means as yet devised for penetrating the rocks which contain mineral treasures but those afforded by the patient and unremitting labour of a great number of men. The regulation therefore of this force, and its due application, is, after all, more important to the success of mines than even the most ingenious mechanical expedients. As an army would undoubtedly fail, however well provided with the most perfect artillery and all the best constructed implements of war, unless the men of which it might be composed were well directed, their efforts well combined, and their courage well assured by reasonable prospects of success, so in mining we may collect and apply the most complete mechanical arrangements; but if the greater power of manual labour be not wisely directed, no beneficial results can be expected."

System of Tutwork and Tribute.—Such being the leading features of mining economy, we may proceed briefly to consider the manner in which they are practically carried into effect, more especially in the deep and extensive mines of Cornwall, where, both from the amount of capital and the number of men employed, every exertion has been made to perfect the mining system, the results of which have since been extended from thence to other parts of England. All the underground work of mines in Cornwall, and indeed of most other districts, is of two distinct kinds: dead work, or that carried on in the rock or metalliferous deposit, for the purpose of trial and discovery; and productive labour, which is employed in the actual breaking down and extraction of the ore. Now it is in the performance of the immense amount of manual labour requisite in these operations, and in the subsequent process of dressing the ores, that the great expenditure of mining consists; and the great merit of the Cornish plan lies in performing the whole by a system of contracts, which effectually unite for a time the interests of the miner and his employer, while, being renewed at moderate intervals, it continually allows of that re-adjustment which the fluctuating circumstances of the mine may require. The dead work is denominated "tutwork," and the raising of ores "tribute;" these two species of employment being, by an excellent division of labour common in all mines, kept entirely separate and performed by different individuals, who thus acquire great skill and judgment in their peculiar occupations. The mode of payment adopted in tutwork and tribute is entirely different: in the former case, where the miner is employed in sinking shafts, driving levels, &c., the object being to extract as much useful labour as possible from him for a given sum, he is paid at so much per fathom, according to the work done; in the latter case, where the quality of the ore raised is a consideration equally important with its quantity, the miner receives a certain per-centage on the actual value, being paid at the rate of so many shillings in the pound upon that value. The excellence of the above principle will readily be seen; and its advantages are still further increased by the open and public manner in which the contracts are made between the men and their employers, thus allowing of free competition as regards the former, and proving an equally effective check against oppression from the latter.

The usual period for making new arrangements with the men is at the end of every two months, when, all previous bargains having expired, both parties are again perfectly free to regulate their contracts. Previously, then, to this day, every part of the mine is visited and inspected by the underground agents, who afterwards consult together, and determine their plan of operations for the next two months, registering in detail the work to be performed, and what they consider as a fair price to be paid for each separate item. On the day appointed for the "setting" or "survey," as it is termed, the men who usually work in the mine, together with others who may wish for employment there, assemble round the mine-office, upon a small covered platform, in front of which the agents, at the appointed time, make their appearance with a book in which their previous examination has been registered. Every piece of work to be performed in the mine is then called out in succession, and accurately defined, and the men make at the time a proposition for working it on certain terms. The price thus offered is, in the first place, usually more than would be fair, or than the men themselves expect to get; consequently, the moment a price has been named, another offer will be made somewhat lower, and so on till fair terms have been proposed, when the competition (except in rare cases) will cease, and the work or "bargain" is considered as taken by the last and lowest bidder, whose name is immediately registered opposite to its description in the setting-book. As each piece of work will require the labour not of one individual but of many, the transaction is still further simplified by the bargain being taken and the contract made with one person only, each gang of men accustomed to work together always selecting one of their number to represent and act for them on these occasions. It is evidently desirable that there should be some plan for binding the men to their engagements, so that they should not be capriciously given up previous to the expiration of the term; and this is the more necessary, as, owing to the frequent fluctuations of richness or of hardness incident to the vein or to the rock in which they may be working, they may find themselves unable to realise the amount of wages which they had anticipated: sometimes indeed the change may be so great, that it is not worth their while to go on with it at all. To meet these contingencies there is in most large mines a printed set of regulations, to which all the miners working there must subscribe; and by which fines are established for the non-fulfilment of contracts, sufficiently heavy to prevent them from being given up while any fair probability exists of their being completed at any reasonable rate of remuneration. In this manner the exertions of the working miner are called into action, and prompted to surmount many of the minor obstacles and fluctuations which often baffle his calculations. Although it may appear harsh to exact a fine when a losing piece of work is given up, it must be remembered that, on the other hand, the vein will often improve in quality instead of deteriorating; and in that case the miner will be greatly benefited, as his labour will be employed upon rich ores at the same high rate of payment that was bargained for poorer ones; and from this favourable change he may benefit as much as the exertions of himself and his co-partners will allow, till the fixed time for the renewal of the contracts again comes round. The set of regulations before alluded to prescribe such other rules and fines as are found necessary for the proper management and conduct of the men; and by means of this simple code, the results of mutual and acknowledged interests, it is found in practice that the necessary discipline can be kept up over the large bodies of men employed in our most extensive mines.

Superintendence.—The mode of superintendence by which the foregoing system is kept in due check is very simple: the principle of self-interest which pervades the whole renders unnecessary much of that minute control which would otherwise be needed. The business of a mine naturally divides itself into several departments—the underground operations, the pit-work and machinery, the dressing and surface-work, accounts and financial matters, and lastly, the general control. For each of these departments proper agents or superintendents are appointed, all being subordinate to a general manager, who communicates and advises with the whole body of the shareholders or "adventurers" at stated periods, or more commonly only with a select committee chosen by them, the whole body meeting but once a year. It may be observed that the agents of a mine are usually chosen from the most intelligent working-miners, who are peculiarly well qualified by their thorough practical knowledge both to form a sound judgment upon the state of the works, and to keep a check upon any frauds which might be attempted by the men, while this selection affords a powerful stimulus to good conduct among them, since it may be attended with such advancement. The general control of extensive mines is of course confided to men of superior education and ability, by whom scientific attainments are brought to the aid of the practical knowledge which superintends the inferior departments.

Education and Qualifications of Miners.—We may conclude this article by a few remarks on the education and qualifications of miners, and upon those institutions which have been established with a view to improvement in this respect. The business of the miner is essentially a practical one, and can only be acquired in the recesses of the mine, and amidst the busy operations carried on upon its surface. Though this obvious truth must be admitted to its full extent, it is impossible not to see that the results of science must, though unconsciously to the miner, be needed at every step. In the most costly, the most anxious, and at the same time the most precarious of all mining processes, the exploration of the ground for purposes of discovery and trial, geology may be made of the highest value: in understanding the nature and value of the heterogeneous mineral bodies presented to our view in underground works, chemistry and mineralogy are essential, and it is entirely upon the former science that the whole art of metallurgy is established. Again, we have seen that machinery and mechanical contrivance are necessary at every step of the miner's progress, a circumstance which renders a knowledge of mechanics indispensable; and in pursuing the complicated operations of underground discovery, loss and error can only be avoided by the aid of geometry and subterranean surveying.

Thus then we may perceive that, in addition to practical knowledge in mining, there is a wide scope for the application of scientific knowledge also; in fact, it is continually in requisition, not merely in the general arrangements, but in the details also, and ought therefore to be possessed, to a certain extent, by the mining classes. Among those nations of Europe by which mining is most successfully cultivated, the value and necessity of scientific knowledge among miners have long been perceived, and ample provisions have been made for its attainment, as may be seen in the mining-schools of France and Germany. Although Great Britain possesses the richest and most productive mines in the world, it is remarkable that, till within the last thirty years, nothing was done in this country to provide the means of instruction for those who are designed for the profession of mining. Thus both the working miner and the mine agent had, in this country, no knowledge whatever of the principles on which the success of their operations depends, but proceeded entirely upon the practical skill acquired in the course of their experience.

Mining Schools.—When treating of the history of mining at the beginning of this article, the establishment of several institutions for the attainment of those acquirements which are needed in the professions of civil engineering and mining was noticed as forming the most recent event connected with the subject, and in course of time the benefits thus derived will no doubt be strikingly apparent. The mining-school of Cornwall formerly placed in operation by Sir Charles Lemon, might have supplied able miners well instructed in all that relates to the working of our tin, copper, and lead mines; while the university of Durham will, it is to be hoped, produce mining engineers whose qualifications will have a more especial reference to the working of coal and other minerals which occur in the stratified rocks of the north of England; and the School of Mines at Jermyn Street, will tend to systematise and diffuse the knowledge of the more general principles of mining. Thus by introducing a system of sound mining education, and by the continual progress of science, aided by the efforts which are now being made by government to supply desiderata which have long been required by the mining interest, we may hope still to maintain our mines in a flourishing condition, notwithstanding their depth, their heavy expenditure, and the increasing competition of other countries.

The total quantities of the metals raised from English mines, in 1858, was given by Mr. Hunt, as follows:—

Tin	6,920	tons.	value	£823,480
Copper	14,456	„	„	1,562,693
Lead	68,308	„	„	1,489,005
Silver	569,345	ounces.	„	156,569
Zinc	6,900	tons.	„	174,225
Iron	3,456,064	„	„	10,713,798
	Total			£14,919,770

MINING, COAL. Although it would be impracticable to enter upon the various modifications of mining processes which are required in the working of all the varied natural depositaries of mineral wealth, the peculiarities of coal-mining are such as to require a brief notice, important and extensive as are the coal-mines of this country, and the arts and manufactures supported by them.

The nature and distribution of our carboniferous deposits have been already fully described in the article COAL-FIELDS, in NAT. HIST. DIV. In working mines of coal, or indeed of iron-stone or rock-salt, and other minerals which are found in beds, the object to be attained is the effectual opening and extraction of a tolerably uniform mass of small thickness, but of great horizontal extension. The process thus differs considerably from the working of mineral veins, where the object of research is fluctuating and irregular in its produce, and either vertical or highly inclined in its position. The thickness of beds of coal may be said generally to vary from three or four to eight or nine feet, although sometimes, when several seams come together without any intervening layers of rock, they may expand to twenty or thirty feet, of which we have an example in the "ten-yard coal" of Staffordshire. In every coal-field there are many seams of coal at greater or less intervals, one below another, of which as many as three or four are frequently worked in the same mine; and interstratified with the rock which divides them there are in many coal-fields extremely productive beds of ironstone, which are wrought at the same time, and in a similar manner with the coal.

The mode of working coal-mines will be most clearly understood by tracing the works from their commencement, in the same manner as in the former article. From the geological indication of coal and the known extension of its beds over very considerable areas, it is pretty certain to be found in the trials which are made for it, if carried on with proper judgment. The probable existence of beds of coal in depth having been ascertained, and perhaps the beds themselves discovered by boring, the first process is to sink a perpendicular shaft from the surface so as to intersect the various strata containing the coal, and of course as many of the beds of coal as are considered to be worth working. The shaft is generally circular, and may vary according to circumstances from six or seven to eight or ten feet in diameter; the upper portion, as far down as the solid rock, is either bricked or walled, and where the ground is weak this casing may be continued throughout. On reaching the first workable seam of coal, the sinking of the pit is for a time suspended, and a broad straight passage termed a "bord" or "gate" is driven from it upon the seam of coal, in opposite directions. The breadth of the passage is usually twelve or fourteen feet, and it is formed the whole height of the seam of coal, so as to expose the stratum above, which is called the "roof," and the one below, which is termed the "thill," and its direction is always arranged so as to follow the cleavage of the coal which forms its sides, which thus present a clean uniform surface. When the bord or "mother-gate" has proceeded some distance on both sides of the pit, narrow passages, termed "headways," are driven from it at regular intervals, and exactly at right angles; and when these have proceeded eight or ten yards, they are made to communicate with another bord, which is opened parallel to the first and on each side of it. It will be seen that by continuing this system of excavation the bed of coal will be entirely laid open and intersected by a series of broad parallel passages or bords of about eight yards apart, communicating with each other by narrower passages or "headways," which cross them at right angles, and likewise traverse the whole extent of the mines; immense square or rectangular pillars of coal being left standing between the two. A coal-mine in this state is not in fact unlike a regularly-built town; the bords and headways may be compared to the principal streets and the narrower streets which cross them; while the pillars of coal may be said to resemble the intermediate masses of buildings.

The water encountered in the above operations is drawn to the surface by a powerful steam-engine erected on the shaft, which is so arranged as also to raise the coal and rubbish, for which purpose either "corves" or baskets are commonly employed. Supposing the above operations to have been successful as regards the prospects of the mine another shaft will now be commenced at some distance from the first, and when the communication between them has been effected, the one being made the downcast and the other the upcast, the air is conducted from the latter to the former through all the bords and workings, which it must traverse in succession in consequence of "stoppings" or doors which are fixed in various places to obstruct its progress and give a proper direction to the current passing to the upcast shaft. Till such communication can be formed, the first shaft may be divided by a "brattice" or partition, and be made to answer the purposes of both; some few coal-mines are indeed worked entirely in this manner, but the danger of explosion is considerable when the workings become extensive.

While the workings on the first seam of coal are thus going on, the shaft may be sunk to a second or third seam, where similar operations will be commenced, small underground pits or "staples" being sunk at intervals from the workings of the upper seam to those on the seam below, by which ventilation will be promoted. These operations, like those described in the former article, may be carried on indefinitely, and will thus in time form an extensive colliery. The regularity and uniformity of the working however are greatly modified by the occurrence of faults and other local accidents, and the pillars themselves are finally removed to such an extent as to cause subsidences of the roof and undulations of the floor, which present a most frightful appearance to the stranger.

The mode in which the pitman carries his excavation upon the coal is by cutting a narrow fissure in the seam on each side of the bord, and undermining the coal between, finally detaching the great cubical mass thus circumscribed by putting in two or three shots, which are simultaneously fired at the top of the seam. From 60 to 80 or 100 tons of coal may thus be brought down at once, when it is put into corves drawn along a tram-road to the shaft, and thence raised by a steam-engine to the surface, where it is often passed over gratings or "screens" in order to separate the small pulverised coal from the larger masses, which in coal countries are alone valuable.

In mines which are not endangered by explosive gases or "fire damp," the coal-miner or "pitman" is guided in his operations by the usual subterranean light—a small candle stuck into a piece of moist clay; but where the fire-damp is apprehended the safety-lamp is used, which has long superseded the primitive contrivance of the steel-mill, the light of which was produced by the contact of a flint with the edge of a wheel kept in rapid motion. Notwithstanding the use of the Davy lamp, and the improvements which have taken place in ventilation, accidents from explosion are unfortunately still of frequent occurrence, although perhaps in most cases they may be traceable to some neglect or imprudence on the part of the men themselves. Attempts have recently been made to apply coal gas to the lighting of tin-mines and coal-mines, both in England and in Belgium; but hitherto without success.

The quantity of coal raised in Great Britain in 1858, was not less than 65,008,649 tons.

MINIUM. [LEAD: *Red Lead.*]

MINOR (Latin), *Less*, or *Lesser*, is a term used to distinguish the mode or key that takes a minor 3rd. It is also applied to all the diatonic intervals, but chiefly to the 3rd. The minor 3rd comprises a tone and a semitone—A, C; the major 3rd is composed of two whole tones—C, E. [KEY; MODE.]

MINOTAUR, son of Pasiphaë, wife of Minos, by a bull. He lived on man's flesh, for which reason Minos put him in the labyrinth of Dædalus, feeding him with criminals, and afterwards with the youths and maidens sent from Athens. Theseus, by help of Ariadne, killed him, thereby delivering the Athenians from the obligation of sending their children to be eaten. Such is the mythological story. Its meaning is uncertain. It very likely belongs to that class of mythological tales which express a political fact, and the connection in which Theseus stands with the Minotaur adds probability to this theory, for the exploits of Theseus are generally such effects as would be produced in historical times by the course of events in the formation of a polity. Such at least are his exploits in and about Attica, and there appears no sound reason to exclude this from the number. It may then perhaps be assumed that under the slaying of the Minotaur is shadowed forth the abolition of certain obstacles existing in the way of free intercourse between Athens and Crete. But the descent of the Minotaur from Pasiphaë (Πασιφάη) probably a name of the moon, and the Bull, one of the zodiacal signs, may perhaps imply some astronomical fact connected with the recurrence of the tribute paid to Crete. The affection of Ariadne for Theseus, in mythological language, may be taken to mean a union of Cretan and Attic tribes. Various other interpretations of a more or less fanciful character have likewise been suggested. The monster either in his early adventures, enclosed in the labyrinth, and fighting with or subdued by Theseus, is frequently represented by Greek artists.

MINSTREL, from the French *menestral*, and that, in all probability, from *Ministrellus*, a diminutive of the Latin *minister*, as a term applied to a class of persons who were to administer by their skill to the amusement of their patrons. "The minstrels," says Percy ('Reliques of Ancient Poetry'), "sang to the harp verses composed by themselves or others." They appear to have accompanied their songs with mimicry and action, and to have practised such various means of diverting as were most admired in those rude times, and supplied the want of more refined entertainment. These arts rendered them extremely popular and acceptable in England and all the neighbouring countries, where no high scene of festivity was considered complete that was not set off with the exercise of their talents; and where, so long as the spirit of chivalry subsisted, they were protected and caressed, because their songs tended to do honour to the ruling passion of the times and to encourage a martial spirit.

The minstrels seem to have been the genuine successors of the ancient bards, who, under different names, were admired and revered, from the earliest ages, among the people of Gaul, Britain, Ireland, and the north, and indeed by almost all the first inhabitants of Europe, whether of Celtic or of Gothic race; but by none more than by our own Teutonic ancestors, particularly by the Danish tribes. Among these they were distinguished by the name of Scalds, a word which denotes "smoothers and polishers of language."

This derivation of the minstrels from the Scalds and Gleemen of the north rests on fair historical testimony; and the reader will not fail to call to mind the incidents recorded of several Saxon and Danish princes, who assumed the disguise of Gleemen, and chanted to the harp when exploring a hostile camp.

The name of minstrel is, however, Norman. "It is well known," says Percy, "that on the Continent, whence our Norman nobles came, the bard who composed, the harper who played and sang, and even the dancer and mimic, were all considered as of one community, and were even all included under the common name of minstrels:" hence we may add their Latin names of *Mimi*, *Scurræ*, *Histriones*, *Joculatores*, &c. In France, however, the name of the class was *Trouverre*, *Trouveur* or *Troubadour*.

Joculator Regis is an officer holding no less than three vills in the return of the Domesday survey for Gloucestershire; and in the same survey, in Surrey, we have a *Joculatrix*. Wace, Gaimar, and our own historians William of Malmesbury and Huntingdon, all concur in the statement that a warrior-minstrel of the name of Taillefer rode before the conqueror's army previous to the battle of Hastings, flinging up and catching his sword in defiance, and singing the song of Roland.

To trace the existence of the minstrel profession minutely through the reigns immediately subsequent to the Conquest seems unnecessary. Rahere, the founder of St. Bartholomew's Priory in Smithfield, is recorded as the "*mimus Regis Henrici I.*"

Warton, in his 'History of English Poetry,' vol. ii., p. 105, has cited several instances of the high pay to minstrels:—"During many of the years of the reign of Henry VI.," he says, "particularly in the year 1430, at the annual feast of the fraternity of the Holy Cross at Abingdon, a town in Berkshire, twelve priests each receive fourpence for singing a dirge; and the same number of minstrels were rewarded each with two shillings and fourpence, besides diet and horse-meat. Some of these minstrels came only from Maydenhithe or Maidenhead, a town at no great distance, in the same county."

From the time of Edward IV., however, the real character of the original minstrel was becoming rapidly extinguished, and even the name seems to have been gradually appropriated to the musician only. At Queen Elizabeth's magnificent entertainment by Leicester, at Kenilworth Castle, in 1575, it is true a personage was introduced to amuse the queen, in the attire of an ancient minstrel, who called himself "a squire minstrel of Middlesex;" but this was, no doubt, a part of the masquerade: it was the representation of a former day, not one of an existing profession. Laneham ('Princely Pleasures of Kenilworth,' Nichols's 'Progresses of Queen Eliz.,' vol. i.) says:—"After three lowlie cooursiez he cleered his vois with a hem and a reach, and spat out withal; wiped hiz lips with the hollo of his hand, for fyling his napkin, temper'd a string or too with hiz wreast, and, after a little warbling on his harp for a prelude, came foorth with a sollem song, warranted for stoory oout of king Arthurz acts."

Before Elizabeth closed her reign the degradation of minstrelsy was completed. By a statute in her 39th year, minstrels, together with jugglers, bear-wards, fencers, common players of interludes, tinkers, and pedlars, were at one sweep included among rogues, vagabonds, and sturdy beggars, and adjudged to be punished accordingly. Ritson quotes some satirical lines in allusion to this statute, written by Dr. Bull:—

"When Jesus went to Jairus' house,
  Whose daughter was about to dye,
He turn'd the minstrels out of doors,
  Among the rascal company:
Beggars they are with one consent,
And rogues by act of parliament."

This act put an end to the genuine old minstrelsy as a profession; and the modern definition of minstrel is no more than a "musician, a player upon some instrument."

MINT, the place where money is coined, from the Anglo-Saxon *mynet* (money or coin), and that in all probability adopted from the Latin *moneta*.

Of the manner in which the Britons conducted the coinage of their rude substitutes for money, few or no notices can now be recovered. The passage from Cæsar, on which the supposition had been founded that the value of the pieces of metal were determined only by weight, has been proved by Mr. Hawkins ('Remarks on the Ancient British Coins,' in 'Monumenta Historica Britannica,' p. cii.) to have been altered in the 17th century. In all the principal manuscripts of the 'Commentaries,' the passage supports the conclusion that the Britons had brass and silver coins. Of the earlier coinage of the country a notice will be found under NUMISMATICS.

If the Romans actually coined money in Britain, of which, we presume, there can be no doubt, their mints were probably superintended by the same officers as were employed in other parts of their dominions; but no documents have yet been produced in proof of it; nor is anything known respecting the mints of the British kings after the departure of the Romans.

On the early Anglo-Saxon coins are found, in addition to the names of the kings, those of other persons also upon the same piece, who are with great probability conjectured to have been the moneyers; because on later Anglo-Saxon money the names of those officers frequently occur, with the addition of their title of office. From the circumstance of their names being inscribed on the coins, if is reasonable to conclude that they were responsible for the integrity of the money; and likewise that they were the principal officers of the mint. The silence also of the Anglo-Saxon laws and of Domesday Book as to other officers of the mint, whilst they so frequently mention the moneyers, strongly corroborates the opinion that they were the only persons employed in the Anglo-Saxon and early Anglo-Norman mints, except perhaps occasional labourers; but an officer called the reeve seems to have had some connection with the mint, or some jurisdiction over it. In the reign of Henry I. the money was so much debased as to call for exemplary punishment on the offenders, which is said to have been inflicted on moneyers only, without the least notice of any other officer. ('Sax. Chron.,' sub An. 1125.) This was also the case upon a similar occasion in the reign of Henry II. ('Chron. Joh. abb. S. Petri de Burgo,' Sparke, p. 78.)

After the Norman conquest the officers of the mint appear to have been, in some degree, under the authority of the court of Exchequer, as they were admitted to their respective offices in that court, and took the usual oath of office before the treasurer and barons.

Ruding observes that if the gerefa, or reeve, above mentioned was not the presiding officer of the Anglo-Saxon mints, he is unable to ascertain at what period it became necessary to place some permanent superintending authority in the mint to prevent any ill-practices of the moneyers; but he thinks it probable that such an officer was appointed between the 26 Henry II., when the moneyers alone were punished for the adulteration of the money, and the third year of Richard I., when Henry de Cornhill accounted for the profits of the cambium of all England, except Winchester. (Madox, 'Hist. Exch.,' vol. ii.)

In the Anglo-Saxon and the early Norman periods there were many mints beside the king's, and some were continued to a much later time. Barons and bishops struck money, especially in King Stephen's reign, and in two or three instances the privilege of coining was granted to greater monasteries. Wolsey's exercise of this franchise, both as bishop of Durham and archbishop of York, is well known: and there are coins of the archbishops of Canterbury, distinctly marked as such, at intervals from Jaenberht, consecrated in 793, to the close of the reign of Henry VIII. . Of the lay barons of Stephen's time, we have but one coin now extant, usually ascribed to Robert earl of Gloucester. Pegge's 'Dissertation on the Coins of the archbishops of Canterbury,' Noble's on those of the bishops of Durham, and more particularly Ruding's enumeration of the places where Mints and Exchanges have been fixed in Britain and its dependencies, will supply the reader with the amplest information upon this subject.

From a very early time the moneyers seem to have enjoyed exclusive privileges. In the 33 Henry II. the moneyers of York were expressly exempted from the payment of the "Donum," which was assessed upon the men of that city. (Madox, vol. i., p. 635.) In the 18 Henry III. the mayor, &c., of London were commanded not to infringe upon the liberties of the king's moneyers of London, by exacting from them tallages or other customs contrary to their privileges (Cl. 18 Henry III., m. 30); and before his 41st year those privileges appear to have been extended to the whole body of officers belonging to the mint; for at that time the bailiffs, &c., of Canterbury were ordered to appear in the Exchequer to receive judgment for having distrained upon the officers of that mint. (Madox, 'Hist. Exch.;' Ruding, 'Annals of the Coinage.')

The earliest grant of these privileges by charter was in the reign of Edward I., when the officers of the exchange and of the mint were (by the names of the keepers of the changes of the city of London and Canterbury, the labourers, or workers, money-makers, or coiners, and other ministers deputed or appointed unto those things which touch the office of the changes aforesaid) freed from all tallages, and were not to be put into any assizes, juries, or recognisance, and were to plead before the said keepers of the changes only, except in pleas appertaining unto freehold and the crown.

These privileges were granted to them so long as they should continue in the above-mentioned offices, and were confirmed by Edward II. in his second year, with this addition, that they were to be quit of all manner of aids and contributions, as well as tallages, and that if at any time they should, of their own proper will, grant any aid or contribution, such should be levied upon them by the keepers of the exchanges aforesaid, and that no other should intermeddle. The keepers themselves were in such case to be taxed by the barons of the Exchequer. Letters-patent to the same effect were issued by Edward III., Richard II., Edward IV., Henry VII., Henry VIII., Edward VI., and Philip and Mary. All these are referred to in the charter of incorporation which was granted by Elizabeth in the first year of her reign, but those of Edward I. and Edward II. alone are given at length.

In that year Queen Elizabeth granted a charter to the workers of the mint, by which important privileges were secured to them. Many of these privileges were enjoyed till a recent period, but were gradually restricted, and are now wholly abolished. In 1799, by the 39 Geo. III. c. 94, the salary of the master and worker of the royal mint was fixed at 3000*l.* a-year, in lieu of all fees, perquisites, and emoluments, which in cases of recoinage were declared to be "excessive;" but the fees were to be received as usual and paid into the Exchequer. In 1831, the act of 1 & 2 Wm. IV. cap. 10 reduced the salary to 2000*l.* a year. In 1837, the 7 Wm. IV. c. 9 enacted that all fees, allowances, or emoluments authorised by the indenture between the master of the mint and the king, should cease altogether from April 5th in that year; that from the same date no part of the seignorage on the coinage of silver or copper should be applied in any way to the expenditure of the mint, but should be paid into the exchequer; and that the treasury might authorise the master of the mint to purchase bullion for purposes of coinage, the means to be furnished from the consolidated fund, the money received for the coin to be repaid into the exchequer, and an account to be laid before parliament within ten days of the commencement of the session.

In 1848 the government appointed a commission to inquire into the working of the Mint system and to suggest remedies. The report presented by the commissioners showed that the system was extremely complicated; and that many of the officials, especially the refiner and smelter, and the moneyers, received inordinately large emoluments. These persons regarded themselves as a sort of close corporate body with vested rights; and it was with the utmost difficulty that the commissioners could obtain from them any details concerning their profits or receipts. The official routine at that time may shortly be described thus:—The master gave to the refiner and moneyers a certain weight of gold and silver, and the latter returned to him a *less* weight of coined money; the difference being their salary, profit, or reward for conducting the refining and coining operations. The master was, himself, always an adherent of the government for the time being; his was a political office, with a salary of 2000*l.* a year; and the holder interfered very little with the proceedings of the regular staff at the Mint. The commissioners recommended very extensive changes to be made. When the late Mr. Sheil was Master of the Mint, in 1850, the government requested him to draw up a plan of reform, based on the report of the commissioners, with such modifications as seemed to him desirable; he did so, entering minutely into the details of the subject. Mr. Sheil being soon afterwards appointed to the embassy at Florence, the government acted on one of the suggestions of the commission, by appointing a scientific person as Master of the Mint, instead of a mere political adherent; Sir John Herschel became master. He approved of the various proposed reforms; and an order in council in 1851 authorised them to be made. It was a most difficult matter to effect a compromise with the assayers, refiners, moneyers, smelters, engravers, and others, owing to the enormous sums which they demanded for a relinquishment of their several privileges; but this was at length effected, and the new system was got into working order by the beginning of 1852. Professor Graham has since succeeded Sir John Herschel. All the officials at the Mint are now paid regular salaries, without any retention of the vicious system of fees and perquisites; and the master is empowered to contract for coining, to be conducted by persons not connected with the Mint, if he thinks the public advantage can be served by so doing. An arrangement was at the same time made, whereby Sir Anthony de Rothschild took a lease of the government refinery at the Mint for ten years; he is bound to refine all the gold and silver that the master may send to him, within a certain maximum and minimum, at a fixed price of 4*s.* per lb. for gold, and 6*d.* per lb. for silver; but he is permitted to refine other bullion also on his own account; while the master is permitted to employ other refiners in addition to Sir Anthony.

There are three matters which must be kept separate, in order to a due understanding of the coinage as a great national manufacture:—namely, the relations between the government, the Bank of England, and the Mint; the relations between the master and his subordinates; and the actual manufacturing operations. Of these three we shall treat in succession in a brief form.

The Mint is bound to convert into coin, at the public expense, any and all gold bullion that may be brought to it for that purpose, if quite or nearly of standard fineness. Practically, the Bank of England is almost the only customer to the Mint in this way, owing to certain facilities which that great establishment has for managing monetary affairs. The gold coins, sovereigns and half-sovereigns, are sent back to the Bank of England in exchange for the bullion received from thence. Sometimes the Bank comes into possession of gold coins of various dates, countries, and standards; these being troublesome to deal with, are converted into "sterling." Bags, containing about 700*l.* worth each, are taken to a refiner's in the city, and melted, each bagful into one bar. The bars are then sent to the Mint to be assayed, and in most cases to be coined into sovereigns and half-sovereigns. The loss by wear and tear, as well as the expense of coining, are borne by an annual vote of the House of Commons. Silver and copper are differently treated. The Mint officers purchase silver bullion, pure copper, and old silver and copper coins, in such quantities as are necessary for the purposes of trade, coin them into silver and copper pieces, and sell or exchange these for gold or notes to any applicants.

The second subject adverted to, namely, the relation existing between the master and his subordinates, or the organisation of the Mint under the new system, may thus be briefly described. The duties undertaken by the Mint are threefold—to receive, and convert into coin at the public expense, all gold bullion of nearly standard fineness, which may be sent thither for that purpose; to buy silver and copper, convert them into coin, and facilitate the exchange by the public of gold or notes for such coin; and to make all such coins for colonial use, and such medals for the public service, as the Treasury may require. To perform these duties there are several departments at the Mint—namely, a Mint office, for the receipt, custody, and delivery of bullion and coin; an assay department, for ascertaining the quality of coin and bullion; a melting establishment, for converting the bullion into bars of the proper standard and proportions for coinage; a coining establishment, for converting the bars into coins or medals; a die establishment, for providing or obtaining the stamps, dies, or engraved devices, to impress upon the coin; and a machinery department, for keeping in due order the various engines and machines employed. Under the old *régime*, the arrangements between all the persons employed were tiresomely minute and complicated; but at present the Mint bears more relation to an intelligible manufacturing establishment.

In ancient times extraordinary methods were resorted to in order to furnish the mint with workmen. Thus in the 31st Henry III., a writ was issued, authorising Reyner de Brussell to bring into England, from beyond the seas, persons skilled in the coinage and exchange of silver, to work in the kingdom at the king's charge. (Pat., 31 Hen. III., m. 3.) And in the 25th Edw. III., Henry de Brussell and John de Cicestra, masters of the mint, were appointed by letters-patent to choose and take as many goldsmiths, smiths, and other workmen in the city of London and other places, where it might seem expedient to them, as should be necessary for the works of the mint in the Tower of London; and to bring the said workmen to the said Tower, and to place them there to work at the wages allowed by the said masters. And any of them which should be rebellious in that case, to seize and arrest, and to detain in prison within the said Tower, and to keep in safe custody until the king should determine upon their punishment. These letters were directed to all sheriffs, &c., who were commanded to assist the said masters in carrying their provisions into execution. (Pat., 25 Edward III., p. 2, m. 13 dors.) This power to take workmen, &c., for the service of the mint was not discontinued in the reign of Elizabeth. ('Indent. with Lorison,' 14 Elizabeth, in 'Harl. MSS.,' Brit. Mus., 698.) The custom of placing the moneyer's name upon the coins prevailed, as already observed, at a very early period in this island; indeed we find it upon the money of Ecghberht, king of

Kent, which is the second in point of antiquity in the Anglo-Saxon series, and must be dated about the middle of the seventh century. It was usually stamped upon the reverse of the coin, but in some few instances it is found upon the obverse, whilst the name of the monarch is removed to the other side. The names of two moneyers sometimes occur upon the same coin. From the time of Aethelstan, with some few exceptions only, the name of the town was added, probably in conformity to his law that the money should be coined within some town. (Wilkins, 'Leg. Anglo-Sax.') The name of the moneyer is not found lower than the reign of Edward I., but that of the mint was not entirely disused in the last year of Queen Elizabeth.

We now come to the third subject—the actual manufacturing processes. The mode of coinage in early times, at least in this country, as far as it can now be traced, was rude and inartificial; the sole expedient employed being to fix one die firmly in a wooden block, and to hold the other in the hand as a puncheon; when, by striking the latter forcibly, and repeatedly, with a hammer, the impression required was at length worked up. This method appears to have been nearly coeval with the first invention of coined money; and it is a singular fact that no improvement of any importance was made in it, until the power of the screw was applied to coinage in the French mint about the middle of the 16th century. (Le Blanc, 'Traité Hist. de Monnoyes de France.')

The present mode of proceeding at the Mint may be briefly described as follows:—

When ingots of gold arrive at the Mint, they are carefully weighed, the weight registered, and a receipt given. Assay pieces are cut from them; and they are assayed, to ascertain exactly how much the gold is above or below standard, if at all. They then pass to the melting-house, where the melter weighs them, and gives a receipt for them. Each ingot is about 8 inches long, 8 inches wide, and 1 inch thick; if the gold be standard, the value is about 800*l.*; and to bring it to standard, an amount of alloy is added depending on the result of the assay. Six ingots, with the necessary alloy, are put into one crucible; and several such crucibles are placed in seven charcoal-heated furnaces. Numerous cast-iron moulds are arranged in a frame; the molten gold is poured into these; and when cold, each mould is opened, and a bar of gold taken out, 21 inches long, 1¾ inches broad, and 1 inch thick, if for sovereigns; but somewhat longer and narrower if for half-sovereigns. If for silver coinage, the ingots are 13 inches long, 5 inches wide, and 4 inches thick, valued at about 250*l.*; the weighing, assaying, melting, and casting into bars, are nearly the same as for gold, but requiring larger apparatus, on account of the greater weight of metal operated upon. The bars into which the silver is cast are 21 inches long, from ⅝ to 2¼ inches wide, and from ¾ to 1 inch thick, according to the kind of coins to be made. The bars are then transferred to the rolling-mill. The machinery next brought into use is of a very powerful character, worked by steam-engines recently set up by Messrs. Hall. There are six pairs of rolling-cylinders, varying from 14 to 10 inches in diameter, all with hardened steel surfaces, and highly polished. Every bar is passed many times through the rollers, which are brought closer and closer to accommodate the reduced thickness. The bars, thus lengthened to 7 or 8 feet, are cut into five pieces each; then annealed in a furnace; then rolled again; and so on—until brought to the respective thicknesses for the different kinds of coin; or rather, slightly in excess of that thickness. All these operations are nearly the same in character for silver and for copper coins as for gold.

The fillets of gold are then transferred to the flatting-mill, where they are passed between rollers exquisitely adjusted, so as to make the fillet uniform in thickness in every part, and exactly thick enough for a sovereign or half-sovereign. Trial-blanks cut from each fillet must not vary in weight more than ¼th of a grain, or the whole fillet is rejected. The cutting-out of a small number of trial-blanks is effected by a hand-punch; but the cutting-out of the blanks which are to form the coins themselves is the work of twelve powerful presses ranged in a circle. The fillets are fed into each press by boys; and stamps, worked by pneumatic power, speedily cut them up into blanks. Each machine cuts out as fast as a boy can feed it (about 60 per minute); and in busy times the whole twelve presses cut about 200,000 sovereign-blanks per day. The scrap or *scissel* is sent back to the melting-house. After another careful weighing and registering, the blanks are tied up in bags and sent to the weighing-room. Men used to be employed, under the name of *sizers*, to weigh each blank separately; but in 1855 twelve exquisite automatic weighing-machines were introduced, the invention of Captain (afterwards Colonel) Harness, the deputy master. Machines of somewhat similar character had been before invented by Mr. Cotton, to be used for sovereigns at the Bank; but those now adverted to are for blanks. The blanks are fed into each machine through a spout; a slide pushes each blank upon a delicate balance, where it remains exactly three seconds to poise itself; if correct in weight to ⅒th of a grain, another slider comes forward and pushes it over the edge into a "medium" or correct box; while the few, very few, which overpass this limit in either direction, are pushed into a "heavy" or "light" box, as the case may be. Under the sedulous care of Colonel Harness and Professor Graham, the rolling, drawing, and cutting-out are now so accurately performed that 98 or 99 blanks fall into the "medium" box out of every 100. All blanks for gold coins, and all for silver coins except those of very small denominations, are now tested by these beautiful machines; these small coins are tested at so many to the ounce, and copper coins at so many to the pound—or, at least, the blanks for them. The weighed blanks are then passed to the marking-machines, which are eight in number; these, by a very peculiar movement, so roll the blanks as to make the peripheries perfectly circular, and to raise a slight projecting edge on each surface—not to produce a *milled* edge, but to facilitate the stamping. After this, the blanks are annealed by being exposed to a cherry-red heat for a few minutes; they are next cooled in water, pickled or blanched in dilute sulphuric acid, dried with heated beech-wood sawdust, and made up into *journeys*, or bags of definite weight, which in the case of sovereign-blanks amount to 15 lbs. troy, or 701 pieces.

The blanks are next coined or stamped. The coining-presses, eight in number, are very strong and massive, having to bear a great strain during the operations. Rouleaux or piles of blanks are supplied to a tube, from which they one by one fall upon the lower die, supported by an anvil; the upper die is brought down upon the blank by a peculiar combination of screw-power and pneumatic power, and a sovereign stamped on both sides falls out, milled, too, at the edge. An analogous process, varied only in details, is employed for other coins. If all the eight presses are fully in action, they will stamp 200,000 coins per day. After being once again weighed, the sovereigns are put up in bags of 701, and these in larger parcels of 5608. On the day after being stamped, the sovereigns are conveyed to a central office, where they are *pixed*, or officially tested. If medals instead of coins are being struck, the operations are lengthened by this circumstance:—that, on account of the high relief of the device, every blank requires many blows and many annealings before it can receive the full effect of the impression.

The amount of coinage in each year varies, according to the fluctuations of internal and foreign trade. In some years it barely reaches 1,500,000*l.*, while in others it has exceeded 12,000,000*l.* During the last twenty years it has averaged something over 5,000,000*l.* annually.

From the money, when completely finished, two pieces are to be taken from every 15 lbs. weight of gold, and two, at least, from every 60 lbs. weight of silver, one for the private assay within the Mint, and the other for the trial of the Pix.

Preparations are now being made for changing the character of the English copper money. The coins are not only very heavy, but they are absurdly unequal. One-fifth of the whole quantity is on an average 60 years old; and the pence then coined are at the rate of 16 to the pound, whereas those of later date are mostly 24 to the pound. The copper coinage at present in circulation is supposed to be about 3500 tons, worth 380,000*l.* as mere copper, but 800,000*l.* as coins. It is now intended to replace the whole of these with bronze coins, consisting of 95 parts copper, 4 of tin, and 1 of zinc. They will be so much lighter than the coins now existing that the government expect a profit beyond all the minting expenses, while the public will probably be well satisfied with the change. A bronze penny or halfpenny will be a *token*, issued for more than its intrinsic value; but where the government keeps good faith, no harm will result. The decided satisfaction expressed in France at the new bronze coinage has influenced the English government in this matter. If, as is stated, there are to be 48 bronze pennies to the pound, the weight of each will be only one-third of that of the massive old "ring" pence of George III.'s reign, and one-half of that of the smaller pennies; and the coins will be useful for weighing, at 3 to the ounce. At the present time (July, 1860), Mr. Leonard Wyon is preparing the dies, and Messrs. Boulton and Watt the machinery, for this new bronze coinage. A partial adoption of the decimal system concurrently with this change has been strongly urged, but no such plan seems to be intended.

A few words will suffice relating to colonial and foreign mints. The Royal Mint, on Tower Hill, makes the coins for most of the colonies; but the colonists have a voice in determining the denominations and values of the coins. The Canadian legislature adopted the decimal system of coinage in 1856, and had entirely new moneys minted to carry out the change. There are twenty-cent, ten-cent, and five-cent pieces in silver, and one-cent pieces in bronze. The sizes and weights have been very ingeniously adjusted, so as to make the coins useful as weights and measures, as well as moneys: thus, the cent pieces are exactly one inch in diameter, and weigh exactly 100 to the pound avoirdupois; they pass current for exactly 100 to a United States dollar, and 24 to an English shilling. The Calcutta Mint, for the service of a vast population in India, has for many years been one of great magnitude; but in 1859 it underwent such augmentations as rendered it the most important in the world; it has at least double the coining power of the London Mint. There are also large mints at Bombay and Madras. Australia, after the discovery of gold in that country, wished to have a mint for coining. Each colony applied in 1851. The government expressed willingness, under proper conditions for security, the colonies to pay the whole expense. The Master of the Mint prepared an estimate, showing that 10,000*l.* would be required for a building and machinery sufficient to coin 5,000,000 pieces annually, and that a larger outlay would ensure a yet larger ratio of increase in productive power. New South Wales, accepting the terms, transmitted 10,000*l.* in 1852 for the commencement of operations. Machinery was sent out in 1854, and the Sydney Mint commenced work in 1855; it coined about 450,000 ozs. of gold into sovereigns and half-sovereigns in a year and a half, and more powerful machinery has since been sent out. In California there is a mint with great producing power, which has undergone gradual enlargement to adapt it to the wants of the gold-diggers and dealers of that country. The United States government has had experimental pieces minted in a mixed metal of copper and nickel; but they are very inferior in appearance to bronze. In France, the coinage is not managed by the government, but by a peculiar company, who are paid by the state at the rate of 1½ francs for coining 1 kilogramme of silver money, and 6 francs for 1 kilogramme of gold, the proportion between the number of large coins and that of small being matter of stipulation. In 1857 the French withdrew their copper coins, and replaced them with lighter and better stamped coins in bronze, realising a very considerable profit by the change, on account of the much smaller quantity and value of metal in the new coins than the old.

MINUET (*menuet*, Fr.), a graceful slow dance, which, according to Brossard, had its origin in Poitou, and, we conjecture, first made its appearance either in the middle or towards the end of the 17th century, for the term is not found in Mersenne, but is met with in the operas of Lully. Ménage derives the word from *menu*, "little," the paces of the minuet being small.

The minuet, as a dance, consists of two strains or parts, of eight bars each, in three-crotchet time, and both are repeated; but as it seems to have been introduced together with hoops and hair-powder, so it passed away with them, and has not revived with their revival: except now and then on the stage, it is only seen in dancing schools. As an exclusively musical movement, in symphonies, quartets, &c., each strain of the minuet generally comprises sixteen bars, both strains being repeated; and it is followed by a second, called the trio; after which the minuet is played once more, straight through. But composers are not very strict as to its length, or to that of its supplement the trio. For the latter kind of minuet we are indebted to Germany: its time is always quick—*allegro;* and when repeated after the trio, the movement is rather accelerated.

MINUTE. [ANGLE; SEXAGESIMALS; TIME.]

MIRACLES. A man may acquire his knowledge of any event in either of two ways; by his own observation, or by information from others. The knowledge of an event which a man obtains from his own observation is generally, to him, the highest degree of evidence and the surest ground of belief; but not therefore the surest ground of a true opinion. The knowledge of an event which a man derives by information from others is not, to him, so high a degree of evidence as that which he obtains from his own observation; but it does not therefore follow that it is not so sure a ground of true opinion. All the knowledge which a man derives from his own observation may be called experience: all that he derives from the observation of others may, for the sake of distinction, be called evidence; it is the experience of others communicated to him, either orally or by writing.

Every event which has taken place, or is said to have taken place, may be the subject of evidence. A man who has witnessed an event himself entertains no doubt of its reality, unless he has some suspicion that a fraud was practised, or that for some reason or other the event of which he was a witness was not such an event as it appeared to him to be. An eye-witness therefore of an event has nothing to guard against, so far as concerns his own conviction, but deception by others, or mistake or misapprehension on his own part. When a man derives his knowledge of an event from the information of others, there is, in addition to the causes of error which may exist where he is an eye-witness, the further cause of error which may arise from the witness whose evidence he receives being interested in deceiving him, or being, from whatever cause, disposed to deceive him. There is no supposable event which may not be the subject of evidence; and when all reason for supposing deception, mistake, or intention on the part of the witness to deceive, is removed, there is no event which, when witnessed, does not thereby acquire some degree of probability. It must be admitted that the ascertaining that there is neither deception, mistake, nor intention to deceive, is generally the main matter in estimating the value of evidence; but the estimating the value of the evidence in any given case is a different thing from determining what may be the subject of evidence, which is the matter that we are here considering.

Man is so constituted, that any event alleged to have taken place is at once placed by the mind either among events which are common or among events which are uncommon. In the former case, before any evidence is furnished as to the fact, there is a disposition to believe that it is true; and even the soundest judge of human events, though he will believe no alleged event without sufficient evidence, readily acquiesces in the probability of an alleged event of a common kind being a true event. In the case of an uncommon event, the matter is different; most persons are indisposed to consider it probable that the uncommon event has actually taken place, and many persons at once assume its impossibility, or at least assume that it has not taken place. But there is no rational ground either for admitting the truth of a common event without sufficient evidence, or for refusing assent to an uncommon event supported by sufficient evidence. An event the most common in the course of human life, an event the probability and possibility of which no man will deny, requires as much evidence in order to be proved as any event the most uncommon or any kind of thing or event that has never been heard of before. In both cases, the testimony of one eye-witness at least is required; and supposing the absence of mendacity in the witness and of all reason for supposing him to be deceived, the uncommon event is proved as much as the common event. How much and what will be necessary in either case to show the absence of mendacity or of deception, is a question that concerns the estimation of the value of the evidence in any given case, and cannot be determined generally.

Thus, it appears that an event alleged to have taken place may either be one of a kind that is consistent with a person's experience, or it may be consistent with it. But the evidence in support of an event of either description may be precisely the same in degree and kind; it may be the evidence of persons of integrity unimpeached, of judgment approved, and of observation and acuteness unquestioned.

In the two cases supposed, the evidence is precisely the same: the only difference is in the mental state of the person to whom it is addressed. All intention or disposition to deceive, on the part of the witnesses, is by the supposition out of the way, and therefore the case is reduced to that of the receiver of the evidence being an eye-witness, and if he believes the witnesses to have as much penetration and judgment as himself, their evidence is as good to him as his own experience would have been; and if he thinks the witnesses have more penetration and judgment than himself, it is better. There is then no reason why a man should not, under the circumstances supposed, believe an event which is inconsistent with his own experience, as well as one that is consistent with it.

The true cause of all the dispute about the reality of events called miraculous is this:—the estimation of the evidence in the particular instance or instances, has been confounded with the question of evidence generally. As a matter of evidence, any fact may be alleged as the fact to be proved, and the possibility of a proof equal in value to the proof derivable from a man's own observation cannot be denied. But whether any alleged fact has been proved or not, is quite a different question. It is not here said that any supposable fact or event may, by possibility, be supported by evidence as strong as that arising from a man being an eye-witness.

The assertion that any alleged event is inconsistent with experience, may mean either the experience of the objector, or the evidence (that is, the experience) of others; or it may mean both. Taken in its widest acceptation, the assertion cannot be properly made of any fact or event alleged to have taken place; for by the supposition, the event is consistent with the experience of the person who bears evidence to it. If a fact or an event should be told to a person, of which there was no similar event on record, it might be said that experience did not show any similar event; but though this might be a very good reason for examining the evidence most strictly, it is no reason at all against evidence in support of it which is free from all the objections above enumerated.

But it may be said, what does this lead to? It leads to this,—to the admission that any alleged fact or event is a possibility; and it leads to the proper examination of the evidence by which it is supported. Suppose the event to be a shower of stones recorded in Livy. The investigation is relieved of one difficulty by the fact of showers of stones being attested by evidence in modern times much more satisfactory than that of Livy. A man may therefore commence such inquiry by admitting that the particular circumstance recorded by Livy may have taken place; though, if he had not satisfactory evidence of such a kind of events having taken place before, he could not commence his inquiry by making such admission; for the admission that such an event might have taken place could only be made when the event was proved to have taken place, and would then be useless. Further; prior to receiving any evidence, we cannot say that the event is one that could not have taken place. Whether a shower of stones, as recorded by Livy, did fall or not, depends for proof exactly on the same principles as other events recorded by him.

Now many of the facts or events which are called miracles are of the kind which may be considered as unlike any other events on record; the fact, for example, of Jesus raising Lazarus from the dead, which we will suppose, for the present purpose, to be the first event of the kind on record. With reference to an event of this kind, Hume remarks, "In order to increase the probability against the testimony of witnesses, let us suppose that the fact which they affirm, instead of being only marvellous, is really miraculous; and suppose also that the testimony, considered apart, and in itself, amounts to an entire proof; in that case, there is proof against proof, of which the strongest must prevail, but still with a diminution of its force, in proportion to that of its antagonist." The opposing proof here referred to is what Hume calls experience, a word which he has used in his Essay in a very loose sense. From what has been said in this article, it will be perceived that the view which the writer takes of evidence is altogether different from that of Hume. If the "testimony, considered apart and in itself, amounts to an entire proof," the thing or event is proved, whether it be one kind of thing or another; and this conclusion is logically contained in Hume's words. It is however clear that Hume did not mean to say that which his words do mean; for he urges against this, which would be entire proof if the thing were not miraculous, the objection that it is miraculous; and this is the whole of the matter that his Essay in effect contains, which, as it has been well remarked, "confounds the principle of belief with the subject-matter to which it is to be applied." (Starkie, 'On Evidence,' i., p. 473, note.)* This is the case in the first part of Hume's 'Essay on Miracles;' the second part merely professes to show that no miraculous events have ever been established on so full evidence as may amount to entire proof.

Every person understands what is meant by the laws of nature. The material world and the world of thought are subjected to certain general laws, or, to speak more accurately, the phenomena succeed one another in a certain order, which, as far as evidence extends backward, has been generally unaltered. We say, generally, for deviations from this order are alleged to have occurred at various times and in various places. Now deviations from those laws are supposed to present, and indeed do present, events which stagger the belief of many persons, and which are regarded by others as totally untrue. Some have gone so far as to say that such events are impossible; thereby destroying the very ground of all evidence, for we can never determine beforehand the truth or falsehood of the matter offered to be proved; unless indeed the thing asserted and proposed to be proved should be a general proposition, and a man should be able by his own experience to contradict it in one or more particular instances: in such case, a man might beforehand deny the thing proposed to be proved. This is in fact Tillotson's argument against the real presence, which Hume "flattered himself" was of "a like nature" with the argument that he "had discovered."

Hume's definition of a miracle, at least the first part of it, appears unobjectionable: it is defined by him to be "a transgression of a law of nature by a particular volition of the Deity, or by the interposition of some invisible agent."

The true notion of a miraculous event then is an event that was inconsistent with the course of nature, as known at the time when the event is alleged to have taken place, and would be inconsistent with it if it were to take place now; and further, it must be such an event as by the supposition is inconsistent with and cannot take place by virtue of the laws of nature as established. If it is an event that happens by virtue of what is called a law of nature, known or unknown, it is not a miracle as the term is properly understood.

If the raising of Lazarus from the dead was an event which took place by virtue of a pre-established law or course of events, in which this one event, to us an apparent exception, was in fact a necessary consequence of this pre-established law or course of events, such event is not a miracle, nor such an event as is generally understood by the word miracle. Those men who would bring miracles within what are called the laws of nature, mistake the question. If the event of the raising of Lazarus from the dead, and all the attendant circumstances, took place in the course of things, agreeably to a general law unknown to us, such an event is as much an event consistent with what are called the laws of nature, as the event of any man's death; but in that case, it is not the kind of event which the New Testament presents to us. Whether however it is the one kind of event or the other, matters not as to the evidence of it, which is in no way concerned about the kind or quality of the event.

To take then the case of a man being raised from the dead; can the evidence of such a fact amount to proof? It can amount to proof as strong as that which a man would derive from being an eye-witness of such an event, and having every opportunity of examining it. Whether, in a given instance, the proof is so strong as this, must be ascertained by weighing the evidence, which is quite a different matter from the possibility of such an event being proved, which is all that is here insisted on. Whether the proof, when made as strong as we have supposed, will convince a man, is no longer a matter that in any way belongs to the general question of evidence. The judgment that a man will form on the report of others must be left to himself. As a man must always decide for himself whether he will trust his own senses, so he must also decide whether he can believe that which a credible witness says he has seen.

Other views of the nature of miracles, of their antecedent probability, historical character, and what is called 'evidential' value, differing more or less from what is set forth above, and, in their sceptical or critical point of view, from that of Hume, have, during the last few years, been repeatedly put forth and answered with great learning and logical acumen on the Continent (especially in Germany) and in our own country. The nature and extent of the controversy would however render it impracticable, even if it were desirable, to enter into it here, where all that has been attempted is to show the principle involved as a question of evidence and antecedent probability. The writings of Paulus, Rosenmüller, Wegscheider, and De Wette in German, and of Theodore Parker, F. Newman, &c., in English, will show the various phases of the recent sceptical and rationalistic reasonings against the credibility of miracles, whilst those of Archbishop Whately, Deans Lyell, and Trench, and Mr. Mansell will supply the arguments by which their objections have been met by what are regarded as the most orthodox authorities. With these may perhaps be compared the views of writers like Neander, Professor Jowett, and B. Powell.

MIRAGE [REFLECTION AND REFRACTION, ATMOSPHERIC, EXTRAORDINARY.]

MIRROR. [SPECULUM.]

MISDEMEANOR is a term applied in the law of England to crimes and offences, whether of commission or of omission, less than felony. [FELONY.]

At common law, persons convicted upon an indictment [INDICTMENT] for a misdemeanor are punishable by such fine, or by such term of imprisonment short of imprisonment for life, or by such amount both of fine and imprisonment, as the court before which the offenders are convicted, in its discretion awards. By several statutes special modes of punishment are provided for some particular misdemeanors. But it frequently happens that even in creating new misdemeanors, the legislature affixes no particular punishment. In such cases, the newly constituted offence is punishable as a misdemeanor at common law. Generally, wherever a statute prohibits an act, as a matter of public grievance, or commands an act, as a matter of public convenience, all things done or omitted contrary to the prohibition or command are punishable as misdemeanors at common law; it being a common-law offence to disobey a statute, even though the act or omission be not attributable to a corrupt motive. Where a statute, in respect of an offence which was a misdemeanor at common law, provides a mode of proceeding different from that of the ordinary course by indictment, either the extraordinary or the ordinary mode may be adopted. Thus if a statute give authority to the court of quarter-sessions to make an order respecting some particular matter, and prescribes a particular remedy in case of disobedience, a party disobeying an order made in pursuance of the statute may be proceeded against either in the mode prescribed by the statute or by indictment. He would be guilty of a misdemeanor at common-law, both as having disobeyed a public statute, and as having disobeyed an order made by a court having authority to make such order. Where however a statute has made a matter a felony which before was a misdemeanor only, the offender cannot be indicted for the misdemeanor, as the minor or lower offence is said to be merged, that is drowned or absorbed, in the higher [MISPRISION]; but the statute 14 and 15 Vict., c. 100, s. 12, provides that if on a trial for misdemeanor, the facts given in evidence amount in law to felony, the accused is not by reason thereof to be entitled to acquittal; and no person tried for misdemeanor is liable to be afterwards prosecuted for felony on the same facts, unless the court discharges the jury from giving a verdict, and directs an indictment for felony. Where a statute creates a new offence, by making unlawful that which was lawful before, and appoints a summary mode of proceeding, the specific statutory course must be pursued, and an indictment will not lie. An act done in contravention of a statute which extends only to private persons, or relates to disputes of a private nature, cannot be made the subject of an indictment; for no injuries of a mere private nature not in any degree concerning the king, and not accompanied by a breach of the peace, can be made the subject of a criminal prosecution. Nor will an indictment lie for an infraction of the bye-law of a corporation. But under some circumstances an indictment will lie for a personal injury, where the act or omission amounts to a violation of duties incumbent on the party as a member of civil society, as in the case of a parent wilfully omitting to supply proper food to an infant unable to provide for itself. Where a child is put out apprentice by an order of magistrates, the master, if he refuse to provide for the child, may be indicted for disobedience of such order. Any act of wilful negligence, whereby human life is endangered, is a misdemeanor; as to put on board a ship a package containing gunpowder, oil of vitriol (sulphuric acid), or other dangerous articles without giving notice of the contents of the package, so as to enable the master of the vessel to use proper precautions in stowing it. Every act done for the purpose of committing either a felony or a misdemeanor, is itself a misdemeanor. By the 14 and 15 Vict., c. 100, s. 9, a person indicted for any misdemeanor may be found guilty of an attempt, and punished accordingly.

As to the former and present course of proceeding upon indictments for misdemeanors, see TRAVERSE.

Where a peer or a commoner is impeached by the House of Commons for a misdemeanor, the lords spiritual as well as the lords temporal are judges. The judgment is pronounced by the lord chancellor, and it is binding though the king dissent from such judgment; whereas in capital cases the royal assent is necessary, and the judgment is pronounced by the lord-high-steward. [STEWARD.]

MISPRISION (from *mesprendre*, which means sometimes to deal improperly with, sometimes to treat with contempt), is a term used in English law in different senses.

I. In the sense of criminal nonfeasance, or neglect to perform important public duties, the term is applied to concealment of treason or felony. Misprision of treason consists in a party's withholding his knowledge of a treason committed, or about to be committed, or in omitting to give information respecting it within a reasonable time to some public authority. If the concealment or omission to reveal the treason be accompanied by express assent to the treasonable act or purpose, or by any circumstances from which a tacit assent will be implied, the party is guilty of high treason, as well as of misprision of treason; and the crown may prosecute either for the higher or the lower offence. Misprision of treason is a misdemeanor [MISDEMEANOR], punishable by imprisonment for life and the forfeiture of the personal property of the offender absolutely, and of the rents and profits of his real property for life.

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* It may not be improper to add, that the writer by no means assents to all the arguments contained in the note referred to.

Misprision of felony is a similar concealment in respect of felonies, and it is punishable by fine and imprisonment. In some, if not in all cases of felony, the party may be proceeded against for the minor offence, or misdemeanor, although a felony has actually been committed by him.

The concealment of treasure-trove [Treasure-Trove] is another species of criminal neglect, which constitutes a misprision punishable by fine and imprisonment.

II. Misprision by malfeasance, (by doing something which ought not to be done,) is the commission of such misdemeanors as are construed to involve a contempt of the royal authority or prerogative. Maladministration in high offices of public trust, though indictable as a misprision, is commonly, on account of its importance, made the subject of parliamentary impeachment.

It is a contempt of the prerogative to refuse to assist the king when called upon, either in his councils by advice, or in his wars by personal service within the realm in cases of invasion or rebellion; to refuse to join the posse comitatus, or power of the county, when duly required by the sheriff or justices; to accept a pension from a foreign potentate without the consent of the king; to go abroad when forbidden so to do either by writ of *ne exeat regno*, or by a general proclamation, or to neglect to return from abroad when commanded by the king's letters; to disobey an Act of Parliament where no particular penalty is enacted; to speak or write against the king's person or government, or do anything tending to lessen him in the estimation of his subjects; to weaken his government, or to raise jealousies between him and his people; to deny the king's title to the crown in common unadvised speech [Præmunire]; to use threatening or reproachful words to a judge in court; to assault or threaten the adverse party in a suit, or his counsel or attorney, or a juror for his verdict, or a jailor or other officer for exceeding his duty; to commit an affray near the courts of Westminster Hall, or at the assizes, but out of the view of the judges; to dissuade a witness from giving his evidence; to advise a person to stand mute; to disclose an examination before the privy-council or a grand-jury. All these are positive misprisions or contempts, punishable by fine and imprisonment. Maliciously striking in the palace in which the king resides, whereby blood is drawn, is punishable by fine, forfeiture, imprisonment, and formerly also by loss of the offender's right hand. Rescuing a person from the custody of one of the superior courts of justice, in Westminster Hall, or at the assizes, is punishable by imprisonment for life, forfeiture of personal property, and forfeiture of the rents and profits of real property during life. A stroke or blow given in any of these courts, whether blood be drawn or not, or an assault upon a judge whilst he is sitting in court, by drawing a weapon, though no blow be struck, subjects a person to the same penalties as those last mentioned, and formerly also to the additional punishment of loss of the right hand.

The misprision which is stated above to be included in the actual commission of treason or felony, may be referred to this second division, as it consists in mal-feasance rather than in non-feasance. (Blackst. 'Com.' by Kerr, v. iv., pp. 119–128.)

III. The term misprision is also applied to careless but involuntary mistakes, or, as they would now be called, clerical errors, particularly those committed by public officers in entering the proceedings in a cause or in a judicial proceeding upon the rolls or records of the court; though it is also applied to misrecitals and mistakes in deeds, &c. (Roll, 'Abr.,' *Grant*.)

MISSAL (from the Latin *missa*), the book or ritual containing the several masses to be used on particular days or feasts.

The Roman missal was originally compiled by Pope Gelasius, and afterwards reduced into better order by Gregory the Great, who called it the Book of Sacraments. The 'Missale Romanum, ex decreto Concilii Tridentini restitutum,' is that at present in use. We have an edition before us, printed at Rome, in folio, 1826.

Anciently, each diocese, and each order of Religious, where they chose, had their particular Missal, accommodated to the festivals of the province or order. They were consequently extremely numerous. The Missals of the 13th, 14th, and 15th centuries, written previous to the discovery of the art of printing, present us, in many instances, with the finest specimens of illumination now preserved in our libraries, and command enormously high prices.

MISSIONS. The 15th verse of the 16th chapter of the gospel by Mark is the great scriptural authority for missions. In the 6th century (590-604) Pope Gregory the Great sent missionaries to Britain, to convert the people to the Christian faith. Similar means were adopted in other countries, until, about the close of the 10th century, when the Christian religion had become the prevailing faith throughout Europe. Other fields for missionary exertion were then sought. Attempts were made to propagate Christianity in Tartary and China; and the Portuguese, who visited Abyssinia about 1490, endeavoured to bring over the Christians of that country to the Catholic faith. The history of this mission may be seen in Mosheim's 'Ecclesiastical History.'

With the earliest maritime discoveries of the Portuguese the desire for the conversion of heathen people was excited with renewed zeal, and may even be said to have been instrumental in stimulating the passion for maritime expeditions. About 1430, Pope Martin V. granted plenary indulgence to the Portuguese who conquered pagan and infidel countries. Columbus himself was strongly urged to discovery by the desire of propagating the Roman Catholic religion.

Modern missions may be said to have commenced at the same period with these discoveries, in which the popes took great interest. On the return of Columbus to Spain from his first voyage, the results were formally announced to Pope Alexander VI.

The work of converting heathen people was at first undertaken in a barbarous spirit. The commanders of the expeditions which Don Henry of Portugal sent out in the 15th century had "orders to convert the natives of the coast of Africa to Christianity;" and nominal conversions were often effected by the sword.

In 1484, Diego Cam brought four natives of Africa to the court of Portugal; they were sent back with presents and a message to their sovereign, desiring him to embrace Christianity. The natives whom Columbus brought to Spain were baptised, the king and the prince his son acting as sponsors. In his second voyage to the new world, Columbus was accompanied by priests with church vessels and ornaments, and they received orders to bring the natives within the pale of the church by "fair means." But fair means were not always adhered to. The natives were baptised by force, and without instruction, and many facts might be adduced to show that at this period true religion made little or no progress in newly discovered countries; and yet during the 16th century not a fleet sailed for India or America without its missionaries.

The stream of missionary enterprise was at length directed and regulated by different religious orders and distinct institutions. One of the objects of the Society of Jesuits, established in 1540, was the extension of the Roman Catholic faith, and the Jesuits soon became the most active and energetic missionaries in heathen countries. Their activity roused the zeal of the Franciscans, Dominicans, and other orders, and early in the 17th century institutions were founded with a view of rendering the labours of missionaries more effective by a preparatory course of training. In 1622, Pope Gregory XV. founded at Rome the 'College de Propaganda Fide,' which was soon richly endowed. Pope Urban VIII. was one of its principal benefactors. This college consisted of 13 cardinals, 2 priests, 1 monk, and a secretary. It sent out large numbers of missionaries to aid the propagation of the Catholic faith in all parts of the world; published books to facilitate the study of languages; distributed works of piety among various nations in their own language; and maintained in various institutions young men intended for foreign missions. To the above institution was added the "College or Seminary for the Propagation of the Faith," founded by Pope Urban VIII. in 1627, which became the central institution in which missionaries were prepared. This establishment is yet in active operation. Numerous institutions of a similar character were soon after founded in France. The "Congregation of Priests of the Foreign Missions" was instituted by royal authority, and about the same time the "Parisian Seminary for Foreign Missions" was established by an association of bishops and other ecclesiastics, for the education of foreign missionaries. The "Congregation of the Holy Sacrament" also a French establishment, was another of these institutions. These establishments were under the authority of the "De Propaganda" of Rome. Henry III. of France took considerable interest in foreign missions, and Henry IV. and Louis XIII. assigned funds for their support. Private associations were also formed in France, in the time of Richelieu, for sending missionaries to Canada, which were joined by many persons of rank and distinction. The Jesuits first visited Canada in 1608. In 1700, at the desire of Louis XIV., they endeavoured to propagate Christianity among the natives on the banks of the Mississippi. Towards the close of the 17th century there were not fewer than eighty seminaries in different parts of Europe which prepared and sent out missionaries. The Jesuits, Dominicans, Franciscans, and Capuchins were the most active in these undertakings, which were conducted on a large scale and with a regularity and combination of means altogether superior to the efforts made immediately after the discovery of America and of the path to India round the Cape of Good Hope.

India, Japan, and China were the principal fields of exertion. The exertions and success of Xavier in Japan and the East Indies will be found in the notice of him in the Biog. Div. China was also for a long time a scene of successful missionary exertion under the direction of the Jesuits. Father Roger, a missionary of this order, first preached the gospel in China in 1581. Matthew Ricci, an Italian Jesuit, was the first missionary who obtained an introduction to the court, and is justly regarded as the founder of the Chinese mission. Ricci proceeded to China in 1583, but he was not introduced to the emperor until 1601, when he presented to him a picture of Christ and another of the Virgin, and obtained permission to preach. Individuals were chosen for this mission on account of their scientific acquirements, and it was Ricci's mathematical attainments which rendered him acceptable to the emperor and the court. Adam Schaal, another of the missionaries, was employed to reform the Chinese calendar and their system of astronomy. Shortly afterwards two handsome churches were erected at Pekin with the permission and under the protection of the emperor. Under these favourable circumstances Christianity made considerable progress. But after several vicissitudes of favour and disgrace, the missionaries were in 1717 accused of seditious designs, and the emperor confirmed a decree prohibiting the building of churches, and Europeans were in future only allowed to remain in China on condition of their promising never to return to Europe. In 1723 the throne was filled by an emperor who at first was rather favourably disposed towards the missionaries; but he afterwards issued an edict under which they were driven from the churches and only tolerated at Pekin and Canton. Duhalde says that above 300 churches and more than 300,000 Christian converts were deprived of religious instruction by this act. Several families of rank were degraded or exiled by the emperor on account of professing Christianity. In 1732 the missionaries, 30 in number, were banished to Macao, having from motives of conscience disobeyed the edict which forbade the propagation of the Christian religion. Converts were at this period kept together by native catechists, and a few of the missionaries remained in China in concealment or re-entered the country by stealth. The mission is still carried on, in spite of the occasional attempts of the Chinese to put it down; the mission of Father Huc and his companions is the most recent, and the missionaries were expelled. There are still believed to be many Christian congregations served by native priests, but the numbers stated are by no means to be depended on, and the congregations are always liable to persecution.

In the 17th century the Jesuits sent many missionaries to the East Indies, to Tonquin, Bengal, Madura, the coast of Coromandel, and to Surat, with but moderate success. Of their efforts in South America, a notice will be found under PARAGUAY, in the GEOG. DIV.

In 1700 the three orders of Capuchins, Jesuits, and Carmelites were the most active missionaries. The Capuchins had 25 missions in Turkey, and missionary stations were established in Persia, Georgia, and Africa. The Jesuits had ten missions in Turkey, and the Carmelites three. Many of these missionaries had acquired a knowledge of medicine, and obtained access to families as physicians. In 1717 the Jesuits supported missions in the islands and continent of America, in Greece, Asia Minor, and the Archipelago, and in Egypt, Syria, and Persia, besides those in India. Louis XIV. made grants of land to the missionaries in Canada, and to them we are indebted for some of the earliest descriptions of North America.

In 1822 the cause of missions was revived in France by the Institution for the Propagation of the Faith, which has committees at Paris and Lyon. Several popes have granted to its members certain indulgences. The 'Annals of the Propagation of the Faith' are published by the society. The funds are placed at the disposal of the Seminary for Foreign Missions, and the superiors of the Lazarite Missions and the Jesuit Missions. There is no part of the world in which Catholic missionaries are not supported.

The first Protestant mission of which we have any notice was founded by the church of Geneva, which sent missionaries to America in 1556; but it is believed to have existed only a short time. Early in the 17th century the Dutch, who had taken Ceylon from the Portuguese, admitted the natives to employments under their government only on condition of subscribing to the Helvetic Confession, and becoming members of the Reformed church. Large numbers made a profession of Christianity, but comparatively few were real converts; and there was a consequent relapse when the coercion was removed by the cession of the island to Great Britain. In Java, Formosa, and Amboyna, the Dutch made attempts to gain converts. Translations from the Scriptures were made in the Cingalese and Malay languages.

It was some time after the English had begun to form settlements in North America before attention was directed to the religious condition of the natives. In 1644 a petition was presented to parliament from a minister of the Church of England, supported by many English and Scotch divines, which urged the duty of attempting to convert the natives of America to Christianity. Soon afterwards an ordinance of the Lords and Commons appointed the Earl of Warwick governor of the islands and plantations of North America; and a committee was appointed to assist him in several matters, "but chiefly for the advancement of the true Protestant religion, and for the spreading of the gospel of Christ among those that yet remain there in great and miserable blindness and ignorance."

In 1646 the General Court of Massachusetts passed the first act "for encouraging the propagation of the gospel amongst the Indians." In 1649 an incorporated body was established with the authority of parliament, under the title of the "President and Society for the Propagation of the Gospel in New England." In 1661 Charles II. renewed the Society's charter, on the ground that it was now fit to lay a foundation for "educating, clothing, civilising, and instructing the poor natives." The design of the Society was to support and maintain ministers and schoolmasters to instruct the natives in the English language, and to teach them useful trades. Eliot, called the "apostle of the Indians," and Mayhew, had already laboured for several years in the conversion of the native tribes of New England. In a narrative of their exertions, published in 1653, and dedicated to Cromwell, an account is given of the conversion of several chiefs. In "A Later and Further Account," published in 1655, Eliot states that a great desire for baptism had arisen amongst the Indians; but never was there a missionary so conscientiously scrupulous as to trusting to professions of this kind. He told the Indians "how necessary it was that they should first be civilised by being brought from their scattered and wild course of life;" and he began the formation of a village, in which they might learn the advantages of living in a community. The Indians were taught various useful arts, and after several years were admitted as church communicants, previous to which they were required to give an account of their conversion and faith at a public examination.

In "A Further Account," published in 1659, there are sermons or short discourses of several converted Indians. Five Indian youths were receiving an education at the Cambridge grammar-school in Massachusetts, two of whom had been examined in Latin before the magistrates and elders of the place. In 1670 several "praying towns," as the villages of the converted Indians were called, had been erected under Eliot's auspices. In 1674 there were four "praying-towns" in Massachusetts. Eliot died in 1690, at the age of eighty-six. Mather, Bourne, Sergeant, and Brainerd succeeded each other in the work of bringing the Indians to a knowledge of Christianity, but none of them laboured so successfully as Eliot. Brainerd was an ardent and enthusiastic labourer, and exhausted himself by his extraordinary exertions. He was sent to America in 1742, by the "Honourable Society in Scotland for promoting Christian Knowledge," and died in 1747.

By the end of the 17th century the population of the English settlements in America had greatly increased, while the means of spiritual instruction had not been proportionally extended, and the small number of Episcopal churches which existed roused the friends of the Church of England at home to make exertions to supply the deficiency. While the conversion of the natives had chiefly attracted the attention of pious persons, it was found, in 1675, that "there were scarce four ministers of the Church of England in all the vast tracts of North America." Compton, bishop of London, prevailed upon Charles II. to allow 20*l.* for passage-money to ministers and schoolmasters who should go out to supply the deficiency; and a royal gift of 1200*l.* was procured to purchase a Bible, Prayer-Book, and the Homilies, for each parish. In 1679 it was stated that there was not a minister of the Church of England either in Pennsylvania, the Jerseys, or New England, and that these settlements were only occasionally visited by the chaplain to the fort at New York. Many families had never attended any public religious service since they left England. The Society for the Propagation of the Gospel in Foreign Parts originated in the desire to supply the spiritual destitution of these and other settlements, and received a charter of incorporation on the 16th of June, 1701. The Society was composed, by charter, of the chief prelates and dignitaries of the Church, and several of the most eminent persons in the state. Archbishop Tennison was the first president. The amount received by the Society in the first four years after its incorporation was—first year, 452*l.*; second, 575*l.*; third, 864*l.*; fourth, 1343*l.* The efforts of the Society were at first directed to building churches and sending out orthodox clergymen to the colonies. At the same time, and also before the Society was chartered, strong representations were made to the government of the important political influence which the French Jesuit missionaries exercised in Canada in keeping tribes neutral or in alliance with France; and at a court held at St. James's, April 3rd, 1700, representations being made to the effect that the five nations of Indians bordering on New York might probably be seduced by the French, the council came to the opinion, that two Protestant ministers, with a competent allowance, should dwell amongst them, in order to instruct them in the true religion and confirm them in their duty to her majesty. The state of the Indians was one of the objects to which the charter directed the attention of the Society, but its funds were for some time expended in maintaining ministers within our own settlements.

About the year 1680 the condition of the negro slaves in our settlements began to excite attention. In 1680 Morgan Godwyn, "some time student of Christ Church, Oxon," wrote a 'Persuasive to the Instructing and Baptising of the Negroes and Indians in our Plantations.' Towards the close of his life, Eliot had begun to instruct the negroes in New York; and in 1704 the Society for the Propagation of the Gospel established catechising schools in New York for the negroes, the number of negroes and Indians in the city being then 1500. In 1727, Gibson, bishop of London, addressed the missionaries in the English plantations, exhorting them to assist in instructing the negroes. In a sermon preached by Beilby, bishop of Chester, in 1783, before the above Society, the civilisation and conversion of the negroes were announced as one of the great objects of the Society.

The Danish and Moravian missions were the first two in which the chief object was the conversion of the heathen; for the Society for Propagating the Gospel was for some time limited in its operations, and may be regarded in the early part of its existence rather as a "Pastoral Aid" Society. The Danish Missions owed their existence to Frederick IV., who about 1705, became anxious that the gospel should be preached in the Danish settlements in the East Indies. Ziegenbalgh and Plutscho, who had been educated at Berlin, were the first missionaries sent out; they proceeded to Tranquebar, on the Coromandel coast. The Danish missionaries immediately established schools, and prepared tracts and small works in the Malabar language. In 1707 their first church was consecrated. In 1708 the translation of the Testament was begun, and completed in 1711: but they had no press, and were obliged to employ transcribers. The Society for the Propagation of the Gospel opportunely forwarded a printing-press, a hundred reams of paper, six cwt. of type, and engaged a printer for the mission. In 1714 the missionaries had published thirty-four different works in the Malabar language, and fourteen others, written by Catholic missionaries, were used by their scholars and converts.

The Moravian missions commenced in 1731, and were supported with singular activity and perseverance. Count Zinzendorf, the founder of the Moravians, or United Brethren, while attending the coronation of Christian VI. at Copenhagen, saw two natives of Greenland who had been baptised by Egede, who had been sent thither in 1721 by the Danish society, and he heard with regret that the government was on the point of abandoning the mission in that country. He exerted himself, and with the assistance of the Brethren successfully established missions in Greenland, as also in the West India Islands, Lapland, Tartary, Algiers, Guiana, and in North America, for the Indians, though experiencing considerable persecutions from the European settlers in Georgia, Pennsylvania, New Jersey, and other places. The efforts of the Brethren were directed to many other places with various success.

In 1742 the Brethren residing in London formed themselves into a "Society for the furtherance of the Gospel." This Society was revived in 1818.

As it is manifestly impossible to detail all the operations of the various societies, we confine ourselves to giving the following table of the date of their institutions, an outline of the places to which their chief efforts are directed, and the amount of the last annual income of each, wherever it can be obtained :—

UNITED KINGDOM.

Inst.	Title of Mission.	Scenes of Operation.	Income.
			£.
1701.	Society for the Propagation of the Gospel in Foreign Parts.	India, Ceylon, South Africa, Guiana, &c. Special	90,000 25,000
1786.	Methodist	West Indies, West and South Africa, India, Ceylon, China, Australia, Columbia, Fiji Islands, France, Switzerland Home receipts Foreign ,,	 106,834 33,170
1792.	Baptist	India, Ceylon, China, West Indies, Africa	29,546
1795.	London	South Africa, India, China, Madagascar, West Indies, Guiana, Polynesia. Home receipts Foreign ,, Special—China ,, India	 80,898 14,281 8,141 4,937
1796.	Scottish and Glasgow (United Presbyterians and Free Church).	India, Jamaica, Caffraria	
1796.	Methodist New Connexion	Canada, Australia, China, &c.	7,611
1799.	Church of England	India, Ceylon, China, Mauritius, Africa, Egypt, North-west America, Turkey, Palestine, Greece, Asia Minor Special for India	132,052 13,576
1809.	London Society for Promoting Christianity among the Jews.	Europe, Palestine, Turkey, Egypt, Persia, and in Great Britain	32,451
1815.	General Baptist	India (Orissa)	
1825.	General Assembly of Church of Scotland.	India, the British Colonies, Jews in Germany, Turkey, Egypt	2,260
1834.	Society for Female Education in the East.	India, China, South and West Africa, Levant	2,955
1835.	United Presbyterian Synod	India, Canada, West Indies, West Africa, Caffraria, the Jews	25,738
1836.	London City Mission	London, and large towns	35,473
1840.	Welsh Foreign	India (north-east of Bengal)	
1840.	General Assembly of Presbyterian Church, Ireland.	India	
1842.	British Society for Propagation of the Gospel among the Jews.	Europe, Palestine, North Africa, and in Great Britain	5,268
1842.	Reformed Presbyterian Synod.	New Hebrides	
1843.	General Assembly of Scottish Free Church.	India, Caffraria, British Colonies, the Jews	60,578
1844.	Free Presbyterian Church in England.	China	
1844.	Patagonian	Patagonia	
1845.	Naval (for Loochoo)	Loochoo	
1850.	Chinese Evangelisation	China, Penang	
1851.	Colonial Church and School	British America, India, South Africa, Australia, West Indies	27,085

Of the missionary societies of the Continent and America we do not give the receipts, but the American Board of Foreign Missions, and the General Assembly of the Presbyterian Church Mission, have the largest incomes among the societies of the United States; the receipts of the first ranging betwixt 70,000*l.* and 80,000*l.* a year; those of the second betwixt 40,000*l.* and 50,000*l.* All the others are small, none of the annual incomes exceeding 10,000*l.*, and some are less than 1000*l.* Of the continental missions, the United Brethren and Berlin Missionary Society are the chief; of these the incomes reach about 15,000*l.* each, while the total of all the rest does not much exceed that sum. The "Institut pour la Propagation de la Foi," which was established at Lyon in 1822, and whose chief branches are at Lyon and Paris, publishes yearly reports, from which it appears that the missionary labours include Great Britain and Ireland, British America, Australia, the United States, India, Ceylon, China, with other places in each quarter of the world. Their income ranges betwixt 150,000*l.* and 160,000*l.* a year.

CONTINENTAL.

Instituted.	Title of Mission.	Scenes of Operation.
1714.	Royal Danish	Greenland.
1732.	United Brethren	Greenland, Labrador, West Indies, Surinam, South Africa, Australia.
1757.	Netherland	Dutch East India Islands, China.
1821.	German (at Basel)	Western Africa, India, China.
1822.	Institution for the Propagation of the Faith.	India, China, British America, &c.
1822.	Paris Society for Evangelical Missions	South Africa.
1828.	Rhenish	South Africa, Borneo, China.
1833.	Berlin	South Africa.
1835.	Swedish (Stockholm)	Lapland.
1836.	Evangelical Lutheran	Southern India, Australia.
1836.	North German	Western Africa, New Zealand.
1842.	Norwegian	South Africa (Zooloos).
1846.	Swedish (Lund)	China.
1850.	Berlin Missionary Union for China.	China.
	Evangelical Society of Paris.	

AMERICA.

Instituted.	Title of Mission.	Scenes of Operation.
1810.	American Board for Foreign Missions.	India, China, Sandwich Isles, Indians in United States, Greece, Turkey, Asia Minor, Syria, Assyria, Persia, Western and Southern Africa.
1814.	American Baptist Missionary Union.	Burmah, India, Siam, China, Indians in United States.
1819.	American Methodist Episcopal	Indians in United States, Liberia, China.
1820.	American Episcopal Board of Missions.	Greece, Western Africa, China.
1833.	Free-will Baptist Foreign	India (Orissa).
1837.	American Evangelical Lutheran Foreign.	India.
1837.	General Assembly of Presbyterians in U.S.	India, Siam, China, Western Africa, Indians in United States, Chinese in California.
1842.	Seventh-Day Baptist	China.
1843.	Baptist Free	Hayti.
1845.	American Methodist	Indians in United States, China.
1845.	Missionary Board of Southern Baptists.	Western Africa, China.
1845.	American Missionary Association.	United States, Jamaica, Western Africa, Siam.
1845.	American Indian Mission	United States.
1848.	Synod of Presbyterian Church in Nova Scotia.	New Hebrides.

In addition to missionary labours, many of the societies of the United Kingdom have caused to be produced and printed translations of the Scriptures and other works into the native languages. Notices of most of these will be found under BIBLE SOCIETIES.

MIST. The vapour of water, when mixed with air of the same or a higher temperature, is invisible; but when the temperature of the air is reduced below that of the vapour, the vapour becomes visible, and forms a *mist.* Water, in the state of vapour, is continually rising into the atmosphere at all the usual temperatures. At and even below the freezing-point water evaporates, and ice and snow, in a dry atmosphere, gradually disappear without becoming sensibly liquid. But as heat is the sole cause of the conversion of water into vapour, the quantity produced, other things remaining the same, is in proportion to the temperature; so that in very hot weather the air is not easily saturated with vapour, and in cold weather evaporation is slow: thus, there is more vapour in the air in summer than in winter, and in hot countries than in temperate climates, in all cases where similar surfaces of water are exposed to the sun's rays. Indeed, it has been found that the quantity of vapour in the air diminishes nearly uniformly with the temperature from the equator to the poles. But as the quantity of vapour which the air will hold at any given temperature is limited, whenever that quantity is near or at the point of saturation, a very small reduction of temperature renders the air misty, and a further reduction converts the vapour into rain.

As every reduction of the temperature of the air has a tendency to destroy the transparency of the vapour which it contains, the atmosphere in our variable climate is seldom very clear. Soon after sunrise however, in fair weather, the vapour near the earth having been precipitated by the night-cold in the form of dew, and the sloping rays of the sun having little power to raise more vapour, the air is almost perfectly transparent, and every object has a clearness and sharpness of outline which it never has at any other time of the day.

When the mist is very thick, it is called a *fog*. The fogs which frequently occur in London in the winter arise from the large quantity of vapour produced by a great city being condensed by cold: and as it is not carried off by winds, it is mixed with the smoke, and forms a thick mass in and about the town; while at a short distance the air is often quite clear, and the limits of the fog may be distinctly observed. The comparative cold of the local atmosphere in the valley of the Thames below London, and its extension up the river, are also concerned in the production of London fogs.

The preceding is a very general view of the nature of mist and its production. On our rivers and seas, towards the end of summer, throughout the autumn and the beginning of winter its frequency and amount are remarkable, and are the cause of much delay and risk to the navigator. The immediate and topical dependence of the formation of mist, however, on the ordinary terraqueous surface, is upon the temperature of rivers and collections of water. This was made a special subject of attention by Sir H. Davy, in his second journey on the continent of Europe, in 1818, and he published the results in the 'Philosophical Transactions' for the following year, pp. 123-131. He thus describes the process by which mist is formed:—"As soon as the sun has disappeared from any part of the globe, the surface begins to lose heat by radiation, and in greater proportions as the sky is clearer; but the land and water are cooled by this operation in a very different manner: the impression of cooling on the land is limited to the surface, and very slowly transmitted to the interior; whereas in water above 45° Fahr., as soon as the upper stratum is cooled, whether by radiation or evaporation, it sinks in the mass of fluid, and its place is supplied by warmer water from below, and till the temperature of the whole mass is reduced nearly to 40° Fahr. the surface cannot be the coolest part. It follows, therefore, that wherever water exists in considerable masses, and has a temperature nearly equal to that of the land, or only a few degrees below it, and above 45° Fahr. at sunset, its surface, during the night, in calm and clear weather, will be warmer than that of the contiguous land; and the air above the land will necessarily be colder than that above the water; and when they both contain their due proportion of aqueous vapour, and the situation of the ground is such as to permit the cold air from the land to mix with the warmer air above the water, mist or fog will be the result; which will be so much the greater in quantity, as the land surrounding or inclosing the water is higher, the water deeper, and the temperature of the water, which will coincide with the quantity or strength of vapour in the air above it, greater."

He proceeds to detail some observations in proof of the correctness of this view, made on the Danube from Ratisbon to Vienna, and at the junctions with it of the Inn and the Ilz; on the Rhine, the Raab in Hungary, in Carniola, on the coast of Istria, and in Italy, including the Po and the Tiber, and the small lakes in the Campagna of Rome.

After mists have been formed above rivers and lakes, their increase seems not only to depend upon the constant operation of the cause which originally produced them; but likewise, Davy inferred, upon the radiation of heat from the superficial particles of water composing the mist, which produces a descending current of cold air in the very body of the mist, whilst the warm water continually sends up vapour; it is to these circumstances that the phenomena must be ascribed of mists from a river or lake, sometimes arising considerably above the surrounding hills. When rivers rise from great sources in the interior of rocks or strata, as they have the mean temperature of the climate, mists can rarely form upon them, except in winter, or late in autumn, or early in spring. Great dryness in the air, or a current of dry air passing across a river, will prevent the formation of mist, even when the temperature of the water is much higher than that of the atmosphere.

This topical cause of the deposition of moisture from the atmosphere is of considerable extent and variety in its modifications, and is not without effect in the economy of nature, "for verdure and fertility, in hot climates, generally follow the courses of rivers, and by the operation of this cause, are extended to the hills, and even to the plains surrounding their banks."

When the vapours in the upper regions of the atmosphere are condensed and become visible, they form clouds. [CLOUD.] When those near the surface of the earth are condensed upon cold objects, they form *dew* and *hoar-frost*. [DEW; HOAR-FROST.]

MITRE (from *mitra*, *μίτρα*, a head-band or diadem), the crown or pontifical ornament worn on the head by archbishops and bishops, and in some instances by abbots, upon solemn occasions.

The original meaning of Mitra, as it appears from Homer, is a "band" or "belt," worn by warriors to protect the lower part of the body. It is used by later writers to signify a band for the head, worn by the Greek females; and also more particularly to indicate the head-dress worn by Lydians, Phrygians, and other nations of Asia Minor, which is sometimes called the Phrygian cap or bonnet.

It is not known when it was first adopted by the hierarchy, but it was probably not till the 7th century, when bishops were first established by the Roman emperors. Gough, in his 'Sepulchral Monuments,' vol. i., p. cliii., says, "The mitres of Christian prelates were borrowed from the Apex or Tutulus of the Flamen Dialis." The peculiar form of the episcopal mitre, divided at the sides and pointed in front, is believed to be a symbol of the parted or cloven tongues, "like as of fire," which sat upon each of the apostles on the day of Pentecost. The pope has four mitres, which are more or less rich according to the solemnity of the feast-days upon which they are to be worn. The cardinals anciently wore mitres, before the hat, which was first granted to them by the council of Lyon in 1245. Furetière, in his 'Dictionnaire Universelle,' says that it was not till the 11th or 12th century that abbots were allowed to wear mitres. The Premonstratensians procured a constitution, which was confirmed by Pope Innocent III., that all the abbots of that order should wear them.

In England the mitre was certainly used by bishops as early as the time of the Saxons, and continued as long as the Roman Catholic religion was that of the state. Since that time (except at the coronation of Elizabeth), the mitre has appeared only as an heraldic ensign, surmounting the episcopal coat of arms, unless perhaps in some occasional instance, such as Evelyn refers to in his 'Diary,' under 20th Dec. 1661. "The bishop of Gloucester preached at the abbey at the funeral of the bishop of Hereford, brother to the duke of Albemarle. It was a decent solemnity. There was *a silver mitre* with episcopal robes borne by the herald before the herse, which was followed by the duke his brother, and all the bishops, with divers noblemen." Mitres were however borne before the hearse at a bishop's funeral much later than the occasion adduced by Evelyn. Anciently, the mitre, as an ornament, seems to have descended from bishop to bishop. Among the Cottonian manuscripts is an order, dated 1st July, 4th Hen. VI., for delivering to Archbishop Chichely the mitre which had been worn by his predecessor. That it was an ornament of great expense may be gathered from the circumstance that Archbishop Pecheham's new mitre, in 1288, cost 173*l.* 4*s.* 1*d.* (See Ducarel's 'Excerpts from the Lambeth Registers; MS. Brit. Mus.')

As an heraldic ornament the mitre of a bishop is only surrounded by a fillet set with precious stones. The archbishop's mitre issues from a ducal coronet, but this appears to be an innovation of comparatively recent date.

MITTIMUS, a legal term applied to certain writs and warrants in which the word *mittimus*, "We (the King) send," is expressed or implied.

If a record of one court be, for any purpose, required to be transmitted to another, as one court can exercise no direct authority over another, the course is, for a writ to issue out of Chancery, requiring the court in which the record is to certify the same to the Crown in Chancery: and when the record is removed into the Court of Chancery by this writ (of *certiorari*), it is sent from the Chancery to the court in which it is wanted by writ of mittimus. The term is, however, in more frequent use as applied to the warrant by which magistrates commit and *send* persons charged before them with offences to the proper custody, in order that they may be forthcoming to answer the charge, when ripe for judicial decision.

MIXTURES, in Pharmacy, signify liquid medicines consisting of several ingredients, either in a state of mechanical suspension in some viscid medium, or in a state of complete solution. In preparing these, care must be taken not to mix in the same prescription substances which exercise an antagonising action on the body, or which are incompatible, from one ingredient decomposing another. Sometimes, however, it is the substance resulting from the decomposition of one or more of the constituent articles which is desired, as in the compound mixture of iron, and in this case decomposition of the materials is indispensable. [INCOMPATIBLES.]

No greater quantity of a mixture should be prepared at one time than is likely to be used before the compound is spoiled, either by the atmosphere, if the materials are of a vegetable kind, or by the action of the various ingredients on each other.

MNEMONICS. [MEMORY.]

MNEMOSYNE. [MUSES.]

MOABITES, a people descended from Moab, the son of Lot by his elder daughter (Gen. xix. 37), and consequently related to the Ammonites, with whom we find them closely connected in their subsequent history. [AMMONITES.] The earliest accounts represent them as dwelling in the country on the east of the Dead Sea and the river Jordan, on both banks of the river Arnon (Wady Modjeb), from which they had driven out the Emim, who were said to be a tribe of giants. (Deut. ii. 11; Gen. xiv. 5.) The plains on the east of the Jordan near its mouth were called from them the Plains of Moab. (Numb. xxii. 1; Josh. xiii. 32; Deut. xxxiv. 1, 8.) At the division of Canaan among the tribes of Israel, this tract of country was given to Reuben and Gad; but by the command of God, the Israelites left the Moabites in undisturbed possession of their country. (Deut. ii. 9.) During the existence of the Hebrew kingdoms, the relations of the two peoples were sometimes friendly, but more frequently hostile, and the details are given or alluded to in many parts of the historical books of the Old Testament. According to Josephus, the Moabites were reduced to subjection by Nebuchadnezzar in the fifth year after the destruction of Jerusalem. ('Antiq.' x. 9, 7.) Their name ultimately disappeared in that of the Arabians.

The Moabites were a pastoral people. (2 Kings, iii. 4.) Their country was well adapted for rearing cattle, and also produced corn and wine. (Ruth, i. 1; Is. xvi. 8–10.) It contained many mountains and fertile valleys, and was well watered by the Arnon, the Zered, and other rivers which fall into the Dead Sea. The land is now desolate, the sand and salt of the desert and the Dead Sea continually encroaching upon it; but the number of ruins of towns,—the remains of ancient highways, often paved, with milestones bearing the names of some of the Roman emperors,—the forms of the ancient fields, which may yet be traced,—all testify to the former existence of a large population, which the fertility of the land was able to support, and which must have continued to exist to a period much later than the time when the Scripture accounts of this people cease.

Ar was their capital, called also Rabbah-Moab, and the ruins still bear the name of Rabba. The ruins are upon a low hill in a plain through which runs the stream Boni-Hamed, which falls into the Dead Sea. They occupy a space of about a mile in circumference, with many remains of private houses, but none entire. The principal objects are a temple or palace, of which a wall and some niches yet remain, the gate of another building, and two Corinthian columns. As there were no springs in the district, two reservoirs were formed, of which the largest has been cut out of the solid rock. There are also several cisterns.

(Burckhardt's *Travels in Syria*; Irby and Mangles's *Travels*; Macmichael's *Journey*; Lord Lindsay's *Letters*.)

MODE, in ancient music, is the order of the sounds forming what may, in modern language, be called the different scales.

The ancients differed exceedingly among themselves in their definitions and on the divisions and names of their modes or keys. Obscure on every musical subject, they are nearly unintelligible on this: they all agree, however, that a mode is a certain system of sounds, and it appears that this system or succession is in itself nothing but a given diapason, or octave, made up of all the intermediate sounds, according to the genus.

In the earliest Greek music whereof we have any account there were but three modes, of which the key-notes were at the distance of one tone from each other. The lowest of these was called the *Dorian*, the highest the *Lydian*, and the *Phrygian* was placed between the other two. Subsequently, by dividing the tones into semitones, two other modes were produced, the *Ionian* and the *Æolian*, the first of which was placed between the Dorian and Phrygian, and the second between the Phrygian and Lydian. At length, by extending the system above and below, new modes were established, which took their names from the former five, adding the preposition *hyper* (*ὑπέρ, above*) for the higher, and *hypo* (*ὑπὸ, below*) for the lower. Thus the Lydian mode was followed by the Hyper-Dorian, the Hyper-Ionian, &c., in ascending; and after the Dorian mode followed the Hypo-Lydian, the Hypo-Æolian, &c., in descending.

In the 'Essai sur la Musique,' by M. Laborde, is a comprehensive table of the modes, with the Greek musical characters, &c.; and in the 'Philosophical Transactions' (vol. li., part 2) will be found a table of the same kind, to "show the tuning of the lyre in every mode," by Sir Francis Styles, an industrious inquirer and a learned original writer on the subject.

Of the then existing modes Plato rejected some, thinking them capable of operating prejudicially on the manners, and Ptolemy reduced the number to seven; the latter, therefore, confined all the modes within the compass of an octave, of which the Dorian mode is the centre, so that the Mixo-Lydian was a 4th above, and the Hypo-Dorian a 4th below; the Phrygian a 5th above the Hypo-Dorian; the Hypo-Phrygian a 4th below the Phrygian; and the Lydian a 5th above the Hypo-Phrygian: whence results the following order:—

1	F	Mixo-Lydian.
2	E	Lydian.
3	D	Phrygian.
4	C	Dorian.
5	B	Hypo-Lydian.
6	A	Hypo-Phrygian.
7	G	Hypo-Dorian.

From these seven modes, with the Hypo-mixo-Lydian,—added, it is said, by Guido,—were formed the eight ecclesiastical modes, or tones, of the Roman Catholic Church.

Mode, in modern musical language, signifies the same as Key; but, though a far more convenient term, is very rarely used in that sense in this country. [KEY.]

MODELLING in clay is so completely a practical art, and depends so much on the experience and formative skill of the modeller, that, beyond a few remarks on the necessary consistency of the clay, nothing more can be given here than an account of the nature and uses of the tools, and some description of the sculptor's process.

The tools, called modelling tools, are made of wood and wire, but no tool is more useful than the finger; indeed tools have been invented as mere aids to the fingers, and are designed to do what they cannot perform. Wire tools are the most useful, being fashioned into loops of various shapes and sizes, round and angular, and fixed into wooden handles. They accomplish any required form without driving the clay on to any already modelled part, the superfluous clay remaining in its place while the wire passes under it and until the tool is removed, when it either falls of its own weight, or is removed by the slightest touch of the modeller. The wire tools are most efficient when applied to concave surfaces, especially those in the close or narrow folds of draperies: the wire is sometimes notched or indented, to give a rough surface to the clay. The wooden tools are made of box and ebony, of various shapes and sizes—curved, straight, pointed, rounded, and flat and broad; the broad tools being notched, and designed chiefly for working the large convex masses, or large folds in drapery. In modelling a bust, especially the features, great nicety is required, and the modeller must be particularly careful not to injure what is already done, by retouching with the tool while clay is adhering to it, or he may risk the complete destruction of his work: the adhering clay will drive up the surface. A good method to guard against this accident is to keep the wooden tools which are used for the finer work soaked in oil; the clay is then not liable to adhere, and much time is accordingly saved in finishing the model. The above is perhaps, without practical demonstration, all that can be usefully said about the working tools.

The clay used is common potters' clay, but should be of the best quality. It must be so wet that it will not stand in a mass much higher than its own width without support. The clay adheres much more to the tools when wet, but it is at the same time much more easily and quickly worked, a matter of great consequence, as the patience of the artist is less tried, and some expenditure of time is saved. The supports for the clay are a most important consideration, for if not properly attended to, the finished work, the fruits of months of labour, might suddenly fall to pieces by its own weight. The support of a figure of the heroic or ordinary size (seven feet) is comparatively easy, but this also exacts strict attention, especially if in any very active or unusual attitude. Sculptors generally model figures of the ordinary size upon a bench or stand called a banker, about thirty inches high, and about thirty inches square,—for a bust it must of course be much higher; above this a solid circular plinth is fixed on a wooden box, and is revolved upon six or more wheels, or what are better, short slightly conical rollers, fixed to the plinth near the circumference: the plinth moves more easily on such rollers than wheels, and the rollers afford a more solid support and last longer. A revolving plinth is necessary to enable the sculptor to see his work on all sides in any light, and it enables him to work on all parts, in one spot, or in the same light. On the centre of the plinth there must be fixed vertically a strong iron bar, about the height of a man, and from about six to ten inches in circumference, according to the weight of the figure; it must necessarily be strong and firmly fixed, as it is the main support of the whole skeleton of supports. In loosely draped figures, which are proportionally heavy, it is advisable to fix a vertical beam of wood to the main iron bar; for though the bar will keep the clay perpendicularly in its place, it is no provision against the sinking of a great mass; and the quantity used in some figures, even of the heroic size only, amounts to about two tons. Two cross pieces of wood must be fixed to the main bar at the shoulders and the loins, from which the supports of the arms and legs must be started; and a third piece may be fixed in the middle to diminish the weight of clay: the supports of the legs must be bars, straight or bent, according to the position of the legs; but the supports of the arms, when not detached from the body or drapery, may generally be made of twisted thick copper wire, small pieces of wood being twisted in with it at short intervals and at right angles, like the pieces of paper in the tail of a boy's kite. The fingers, if separated, will require similar care; indeed the clay should be gradually built up against a complete skeleton of supports and sufficiently strong not to yield in the least to the weight of the clay when the model is finished. The building of such a skeleton for a figure of the heroic size is often the work of a week or more, and it would be always advisable for the young sculptor, in modelling his first figure, to procure some experienced hand to construct his skeleton of supports for him. If an arm is slightly elevated, and detached from the figure, the support might be so contrived as to allow the arm to be removed at pleasure, which would enable the sculptor to model the part beneath it with much greater ease, and would considerably diminish the risk of injury to the arm. The contrivance is easily accomplished, for nothing more is required than a pipe or tube in the shoulder support, which could receive and hold firmly the skeleton support of the arm, which might be a bar of wood or of metal; or thick or twisted wire, when of a small size. In modelling a bust very little support is necessary, an upright piece of wood with a cross-bar at the shoulders being quite sufficient; but a small cross-bar at the head would do no harm.

Another essential part of modelling is preserving the moisture of the clay, which should be always uniform if possible; it must never be allowed to dry, and it can be kept moist with very little trouble.

While the modeller is at work, and the figure is exposed, especially in warm weather, he should repeatedly sprinkle it with water. A plasterer's brush is the best instrument for this purpose, and much superior to a syringe or the mouth, which some sculptors formerly used to apply as a squirt, even in the presence of their sitter, when modelling a bust: Nollekens, according to his biographer Smith, adopted this elegant mode of keeping his clay moist while modelling the bust of George III., and in the king's presence. Bacon, on a similar occasion, used a silver syringe. At night time, or when the artist is not at work on the model, it should be covered over with a wet cloth or sheet. A figure may be kept moist for a long period without adding water, provided the air be kept away from it; this may be done by an oil-silk or any air-proof bag, which can be made fast to the plinth of the banker by clay. Sculptors generally model flowing draperies from lay-figures. When the model is complete, the next process is to take the cast, to work the marble from, or to make other casts from. The whole model, while wet, must be covered, in two or three masses, or more if necessary, with plaster of Paris; when this is fixed and dry, the whole may be separated at the joints, without any regard to the preservation of the model, for when the mould is taken the model is no longer of any value. When the clay is completely removed from the mould, the component parts of the mould must be again put together, and in the place of the original clay it must be filled with plaster of Paris, and when the cast is well set, the mould may be carefully broken off in fragments, and the cast is exposed, and complete, the finished work. If casts of it are required, a new working mould, or *safe mould*, as it is termed, must be taken, in many parts. If the figure is to be executed in marble, it is copied by the carvers, with the assistance of the pointing-machine, which is so contrived that it can diminish or increase the scale of the model with perfect ease and nicety. It is always best to make the model of the size of the intended figure if practicable, because any error in a small model becomes multiplied in a larger one in proportion to the difference of size. Flaxman was in the habit of making small models, and he had in consequence sometimes immense labour to go through to diminish errors in the full-sized marble work: it is hardly possible to completely rectify them.

The ancient sculptors used to bake their models, but this is not so good a plan as making plaster casts from them, though less troublesome and much cheaper: the clay in drying shrinks, and is apt to crack, and certainly never comes out of the oven the same shape that it was when put into it, or at least when originally modelled. These baked models are called terra-cotta (*baked earth*) figures, are extremely numerous, and are generally of small dimensions, but there are a few of a large size in various European museums. The ancients made also moulds of clay, which they likewise baked, and they formed their casts by pressure of clay into these: this practice of pressing clay, or any malleable substance, into a mould is still occasionally had recourse to in works of fine art, and constantly in the potteries, and by frame-makers.

The ancients used also wax for casting and in forming their models, especially those of the small bronzes, which are still so exceedingly numerous, and it is the common material used by goldsmiths and medalists. Modelling wax is prepared by melting virgin wax with a very small quantity of Venice turpentine and flake-white in fine powder: if coloured wax is required, a colour in fine powder must be substituted for the flake-white. The tools used in modelling in wax are made of wood and ivory, and have the same shapes as those of wood, already spoken of, for modelling in clay. Other processes in the art of sculpture will be found explained in the articles BRONZE; FOUNDING; SCULPTURE; and WAX MODELLING.

MODELS, ARCHITECTURAL. Besides the usual delineations upon paper showing the plans and different parts of a building, and their details in elevations, sections, and working drawings [DESIGN; ARCHITECTURE], a solid representation or miniature facsimile of the proposed edifice is sometimes formed, in order to give a more distinct idea of it than can be obtained from a number of separate drawings by those who are unable to comprehend them perfectly, and combine them mentally, so as to figure to themselves a complete and distinct image of the whole. Models of this kind are variously executed, and more or less finished up, as may be required. Sometimes they are of wood, either coloured or not; and if economy is studied, the capitals of the columns, the cornices, and all other decorative parts, are merely blocked out in the rough, the mouldings and ornaments being omitted. But the material now more generally used is plaster of Paris, because columns and other parts that require much carving may be cast in moulds, and afterwards finished up with comparatively very little trouble or expense. Another material employed for making architectural models is card-board, applied in surfaces of various thicknesses; and although it seems fitted only for very plain buildings, it is capable of being wrought so as to express even the minute and elaborate tracery and other ornaments in Gothic architecture: models thus formed are less beautiful than those of plaster, but they are less susceptible of injury, and may be more easily coloured to represent the different materials—stone, brick, wood-work, slate, &c. They are however more expensive, being attended with much greater labour, and requiring to be built up, as it were, like the edifice itself.

Models are by no means so generally made use of as they ought to be, on account of their expensiveness; but when a building of great magnitude is to be erected, the cost of a model, although it may be considerable in itself, becomes a mere trifle in the sum-total. Where merely the façade of a building will be exposed to view, a model may be dispensed with, as a simple elevation will answer the purpose quite as well. But for one that is insulated, or is at all complex, a model becomes desirable: the same again if a façade is composed of many parts or surfaces, some projecting, others retiring, the effect of which cannot else always bo so distinctly foreseen as it ought to be, except perspective drawings be made of it from several different distances and points of view. For showing the internal parts of a building, models are of comparatively little use.

Portrait models of celebrated edifices are frequently introduced in libraries and galleries, either as restorations of the original structures, or as showing them as dilapidated by time. For those of the last-mentioned kind, cork is the material usually made use of, it being well calculated to express of itself the ruggedness and flaws of decayed stone buildings.

MODES, *Ecclesiastical* (*Tuoni Ecclesiastici*), or *Tones of the Church*. In what is called the Gregorian Chant there are eight modes or tones—four Authentic and four *Plagal*. [AUTHENTIC; PLAGAL.] The Authentic modes are the Dorian, Phrygian, Lydian, and Mixo-Lydian of the ancients, which correspond, according to Dr. Burney, to D and A minor, C and D major, of the moderns. These were chosen by St. Ambrose, about the year 370, for the church of Milan. The Plagal modes are the Hypo-Dorian, Hypo-Phrygian, Hypo-Lydian, and Hypo-mixo-Lydian, corresponding to G and A minor, F and G major, and were added by St. Gregory about 280 years after the adoption of the former. It must be observed, that the Gregorian Chant has its dominant, but takes this name from being the note most often heard: hence it is frequently mentioned in the Gregorian schools as the key-note.

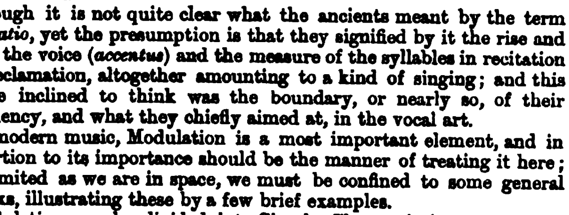
MODILLION (Architecture), an ornamental member in the Corinthian cornice, resembling a small bracket placed horizontally, that is, with its back against the soffit of the part it supports, in which respect it differs from the console, which is placed upright, with its back against the vertical face of the part to which it is attached, and with its larger or convex end uppermost, whereas the larger end of the modillion is placed backwards, and its smaller one in front. Yet though they thus far differ both as to the mode and the purpose of applying them, and also as to their details, in general form the modillion and the console closely resemble each other, the face being composed of a curve of contrary flexure. Modillions are placed beneath the corona of the cornice, and although sometimes omitted out of parsimony, are indispensable to the character of the order, being quite as much distinguishing marks of its entablature as mutules are in the Doric and dentils in the Ionic cornice. [See the cuts in the article COLUMN, cols. 47 and 52.)

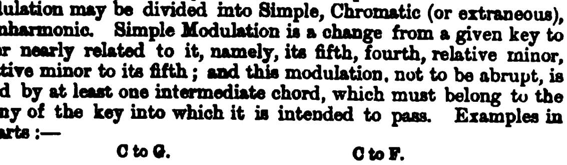
MODULATION, in Music, is a changing of the key, or *mode*, during the progress of a composition. The word is derived from the Latin verb *modulor, to compose or sing in measure*, melody of some sort being inferred.

Though it is not quite clear what the ancients meant by the term *modulatio*, yet the presumption is that they signified by it the rise and fall of the voice (*accentus*) and the measure of the syllables in recitation and declamation, altogether amounting to a kind of singing; and this we are inclined to think was the boundary, or nearly so, of their proficiency, and what they chiefly aimed at, in the vocal art.

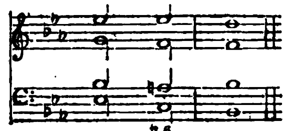
In modern music, Modulation is a most important element, and in proportion to its importance should be the manner of treating it here; but limited as we are in space, we must be confined to some general remarks, illustrating these by a few brief examples.

Modulation may be divided into Simple, Chromatic (or extraneous), and Enharmonic. Simple Modulation is a change from a given key to another nearly related to it, namely, its fifth, fourth, relative minor, or relative minor to its fifth; and this modulation, not to be abrupt, is effected by at least one intermediate chord, which must belong to the harmony of the key into which it is intended to pass. Examples in four parts:—



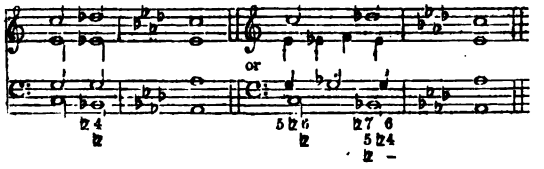


The close resemblance of the scales of G, F, A minor, and E minor, to the scale of C, renders the modulation easy and natural; hence we have termed it *simple*. And it must now be observed, that the natural major key is here chosen as the diverging point merely on account of its apparent simplicity; any other would have answered the purpose, provided the same relations had been preserved. Thus, for instance, from the key of E♭ to its fifth B♭, is relatively the same as from C to G. Example:—

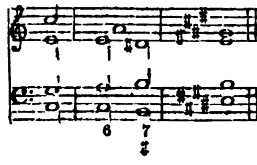


Chromatic Modulation is the change from a given key to some other not analogous to it; that is to say, to one differing much in scale, and, consequently, in signature. [SIGNATURE.] Examples:—

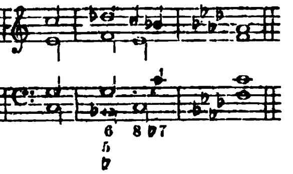
C to A♭.



C to E.

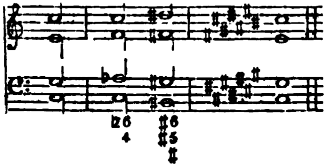


C to F minor.

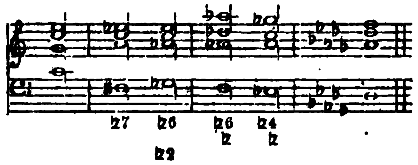


Enharmonic Modulation is the change from a given key to another quite unanalogous, by means of an enharmonic interval,—that is, by the same interval binominously considered; as C and B♯, A♭ and G♯, &c. [ENHARMONIC.] Examples:—

C to C♯.



C to D♭ (from Kirnberger).



In these examples we have endeavoured to show the most direct method of modulating, and, except in one instance, by means of the dominant 7th and the diminished 7th, or their inversions. By the intervention of a few additional chords, more elegant effects might have been produced, both as regards harmony and melody. But it must also be remarked that suddenness of transition is often essential to the design of the composer, in which case he takes the shortest road from key to key that the ear will permit.

It will be seen that we entirely differ from those who—perhaps misled by the word *modulatio*, and its interpretation by ancient writers—think that modulation may be carried on without any change of key. We are decidedly of opinion, though in opposition to some highly respectable authorities, that *modulation* and *change of key* are identical terms.

MODULES (Architecture), from the Latin *modulus*, as being a lesser measure than the diameter of the column, is employed to signify one half of the latter, or thirty *minutes*. Some writers reckon entirely by *modules* and *minutes*. Thus, instead of saying a column is eight or eight and a half diameters high, they would describe its height as being sixteen or seventeen modules.

MODUS. [TITHES.]

MOHAIR, as a material for textile manufactures, has been brought very extensively into use within the last few years. It differs from alpaca in this: that the latter is the wool or hair of a South American animal of the llama tribe [ALPACA-WOOL]; whereas mohair is the covering of a goat peculiar to Asia Minor. Twenty years ago, the quantity of mohair imported was small, but now it is very large; for the manufacturers of the north, especially the great firms in and near Bradford, display much ingenuity in combining two or more fibrous materials, to produce what are called fancy fabrics. Under the names of vestings, pantaloon-stuffs, ponchos, shoe-stuffs, cravatings, linings, cassinets, cashmeerets, barèges, tabinets, shawl-cloths, &c. numerous fabrics are woven, in which wool, worsted, alpaca, or mohair are introduced, or two or three out of the four, according to the softness, thickness, and price of the article to be produced.

The manufacturing processes are similar in character to those described under WOOLLEN AND WORSTED MANUFACTURES.

MOHAWKS. [NORTH AMERICAN INDIANS.]

MOIDORE. [MONEY.]

MOIRÉ, a French word, having the meaning of *clouded*, *mottled*, or *watered*, is applied as a name to two different kinds of effects produced in manufactures: the one on metals, the other on textile goods.

The *moiré metallique*, first introduced by the French, presents a singular beauty and richness of appearance, something like the crystallised frost on a window in winter. The substance is formed of tinned iron plate, while the surface effect is due to the chemical action of acids. The *moiré* appears to be formed by the action of the tin on the iron at the point of contact; and the purpose of the acid is rather to render this visible than actually to produce it. Tin plate consists of a piece of sheet iron coated with a thin layer of tin while the latter is in a molten state; and the art of preparing the *moiré metallique* consists in removing all except an extremely thin film of this tin, without really exposing the iron in any part. Various acids and mixtures of acids will effect this, but the one usually employed is diluted nitro-muriatic acid. The plate of tinned iron, after being slightly heated, is washed with the acid. As soon as the workman sees the moiré develope itself, he plunges the sheet into cold water, and gently washes off the acid and dissolved tin with a feather or a bit of cotton wool. The time necessary to produce this action varies from one to ten minutes according to the strength of the acid and the heat of the plate. When the moiré has been properly developed, and the acid and tin removed, the plate is carefully dried, and the variegated surface protected by a coating of varnish; if the varnish be white, a silvery or pearly moiré is produced; if coloured, richly diversified tints are obtained. A modified kind of *moiré metallique* is produced by the action of heat without acids. The plate of tinned iron is exposed to such a temperature as will melt the tin; and varied effects are produced according to the mode and rapidity of cooling. If cooled gradually, the surface presents a certain kind of moiré or crystallisation; if suddenly cooled by plunging in cold water, the moiré is different in character; if unequally cooled by water being sprinkled on certain parts, or wind blown upon them, the effect undergoes still further variations. So, on the other hand, if the heating of the plate can be so managed as to be unequal at different parts, a variation in the moiré results; and attempts are sometimes made to give a definite pattern to these irregularities. Nobili has produced some very beautiful *metallochromes*, or richly coloured spots on surfaces of steel, silver, and other metals; and Mr. Gassiot has varied the effects of surface thus produced; but the work is one kind of electro-metallurgy, and the effect bears little resemblance in appearance to *moiré metallique*. As a question of mere fashion, the last-named material is not now used so much as it was twenty years ago, when kaleidoscopes and ornamental boxes were covered with it; but it nevertheless remains among the list of articles available for decorative manufactures.

The moiré effect on textile goods, generally called *moiré antique*, is produced mostly in broad silks for ladies' dresses. It is a superior kind of that which is known as *watering* in silk; and the *moireurs*, or calenderers, endeavour to keep secret the exact mode in which it is performed. The moiré, clouding, or watering, is not produced in the dyeing, the spinning, or the weaving; it is a sort of calendering or pressing between two cylinders. By using cylinders hot or cold, embossed or plain, by sprinkling the silk or not with water, and by folding two layers of silk over each other either rectangularly or diagonally, various kinds and degrees of moiré may be produced; those threads, whether of warp or weft, which happen to be most pressed, receive most gloss; some of them become flattened; and the reflection from their surface is glossy or otherwise according to the angle at which they are viewed. Thus a very brilliant play of light and shade is produced, although all the threads may be of one colour throughout.

MOLASSES, is the uncrystallised syrup produced in the manufacture of sugar. It is suffered to drain from the casks into a cistern, in what is called the curing-house, before the sugar is sent away from the plantation. To facilitate the draining, the casks are ranged upright on a frame-work of open joists over the cistern; several holes of about an inch diameter are bored in the bottoms of the casks; and before the newly made sugar is put into the hogsheads, or, as it is called, *potted*, an equal number of plantain-stalks, or sugar-canes from which the juice has been expressed, are placed in each cask, so that the ends protrude through the holes. These stalks or canes must be of equal length with the cask, and they thus form so many channels or conduits for the passing away of the greater part of the molasses: some will always remain in the hogsheads, and, draining away by slow degrees, will in a great measure be lost during the voyage; but even after the arrival of the sugar in Europe a proportion of molasses, which is less or more according to the good or bad quality of the sugar, remains in the mass. See further under SUGAR MANUFACTURE.

Nearly all the molasses made in the English sugar colonies was formerly converted into rum by fermentation and distillation on the estates; but the price of that spirit having declined, and improvements having been made in the processes of refining sugar in Europe, whereby a large proportion of West Indian molasses has been rendered crystallisable, a considerable and continually increasing quantity of molasses is shipped for that purpose. The syrups, which ultimately remain in a liquid form after passing through the processes of a refining-house, whether the same are the produce of Muscovado sugar or of molasses, are sometimes called molasses, but are more generally known as treacle. The imports of molasses, which were only 40,000 cwts. in 1820, rose to 250,000 cwts. in 1830; in 1845 they were more than 500,000 cwts.; and in the 14 years thence to 1859, they varied from about 600,000 to 1,100,000 cwts.

MOLECULAR ATTRACTION—MOLECULAR THEORY. In chemistry it is conceived that bodies are made up of indivisible atoms, each having a definite uniform weight and a general character. The service that this theory has rendered to science may be seen by consulting ATOMIC THEORY. The ultimate particles of matter are termed *atoms*, the word molecules being applied to the constituent or heterogeneous whole. [MOLECULE.] If the molecular constitution of bodies were known,—that is, the specific nature of these molecules,—and the laws of the forces which retain them in connection, whether these forces be of attraction or repulsion, science would then be able to define the changes and sequences of the material universe. Various efforts have been made from time to time to construct theories on this ground sufficiently general to afford a basis for important and wide conclusions, and yet to avoid injurious restrictive conditions. According to the theory of Boscovich, matter does not consist of solid particles, but of mere mathematical centres of force. Each body is supposed to be made up of a number of geometrical points, from which emanate forces following certain mathematical laws, in virtue of which the forces become at certain small distances attractive, at certain other distances repulsive, and at greater distances again attractive. [ATTRACTION.] "From these forces of the points arise the cohesion of the parts of the same body, the resistance which it exerts against the pressure of another body, and, finally, the attraction of gravitation which it exerts upon bodies at a distance."

Dr. Whewell, from whom we have just quoted ('History of Scientific Ideas,' vol. ii., 1858), regards this theory as homogeneous and consistent, and thinks it probable that it may be used for investigating and expressing true laws of nature, although the attempt to identify the forces by which the particles of bodies are bound together with mechanical attraction appears to be a confusion of two separate ideas. This theory, he remarks, "may be so conceived as possibly to involve an explanation of all the powers which their parts exert (such powers, namely, as those which produce optical, thermotical, and chemical phenomena); but this theory cannot supply an explanation of the mechanical properties of a body as a whole, especially of its *inertia*. A collection of mere centres of force can have no inertia. If two bodies are considered as two collections of centres of force, the one attracting the other, there is in this view nothing to limit or determine the velocity with which the one body will approach the other. A world composed of such bodies is not a material world; for matter implies not only force, but something which resists the action of force."

Representing matter as a collection of molecules or centres of force, modern chemists have used the molecular hypothesis as a basis for calculations respecting the elementary forces of bodies, supposing the properties of bodies to depend upon forces emanating from immovable points of their mass. The mechanical philosopher, also, thus treats the properties of bodies on a small scale as Newton had already done with central forces on a large scale. Newton himself remarks, in the preface to his 'Principia,' "Many things induce me to believe that the rest of the phenomena of nature, as well as those of astronomy, may depend upon certain forces by which the particles of bodies, in virtue of causes not yet known, are urged towards each other and cohere in regular figures, or are mutually repelled and recede; and philosophers knowing nothing of these forces have hitherto failed in their examination of nature." Laplace, following up this hypothesis, has shown its value, if we suppose the forces exerted by the particles to decrease so rapidly with the increasing distance from them that the force is finite only at distances imperceptible to the senses, and vanishes at all remoter points. "He has taught the method of expressing and calculating such forces; and he and other mathematicians of his school have applied this method to many of the most important questions of physics, as capillary action, the elasticity of solids, the conduction and radiation of heat. The explanation of many apparently unconnected and curious observed facts by these mathematical theories, gives a strong assurance that its essential principles are true. But it must be observed that the actual constitution of bodies, as composed of distinct and separate particles, is by no means proved by these coincidences. The assumption, in the reasoning, of certain centres of force acting at a distance, is to be considered nothing more than a method of reducing to calculation that view of the constitution of bodies which supposes that they exert force at *every* point. It is a mathematical artifice of the same kind as the hypothetical division of a body into infinitesimal parts in order to find its centre of gravity, and no more implies a physical reality than that hypothesis does." Dr. Whewell, to whom we owe this quotation, refers also to Poisson's views of capillary action, and also to Wollaston's attempt to bring the doctrine of ultimate atoms to the test of observation in the case of the ATMOSPHERE, under which head some notice of Wollaston's argument will be found. But we may here remind the reader of Wollaston's conclusion that the observed phenomena accord with the supposition that the earth's atmosphere is of finite extent, limited by the weight of ultimate atoms of definite magnitude, no longer divisible by repulsion of their parts. We must, however, refer to Dr. Whewell's work for his objections to this line of reasoning, and conclude by naming the most important works which have of late years assisted the molecular theory, such as Gauss on 'Terrestrial Magnetism;' Ohm's 'Contributions to Molecular Physics,' in which he supposes that the ultimate molecules of matter have both simple and polar powers, and by means of this hypothesis he attempts to form a complete system from which the phenomena of light, heat, and electricity necessarily arise; Mr. Grove's work, 'On the Correlation of the Physical Forces,' is also in the same direction.

MOLECULE. Matter is supposed to be made up of indefinitely small particles or *molecules*, which in a simple substance are called *integrant*, or *homogeneous*, and in a compound, *constituent* or *heterogeneous*.

MOLECULES. The smallest indivisible quantities of matter which take part in chemical re-actions. [ATOMIC WEIGHTS; CHEMICAL EQUIVALENTS.]

MOLYBDENUM (Mo). A rare metal, occurring native chiefly as the bisulphide, a mineral that, in appearance and properties, so much resembles graphite as to have been mistaken for that substance until the year 1778, when its peculiarity was first pointed out. A description of the two or three ores of molybdenum that have hitherto been discovered will be found in the NATURAL HISTORY DIVISION, article MOLYBDENUM. The method of isolating the metal from the sulphide is also there detailed. The equivalent of molybdenum is 46.

Molybdenum and oxygen form three compounds:—

1. Protoxide of molybdenum	MoO
2. Binoxide of molybdenum	MoO_2
3. Molybdic acid	MoO_3

1. *Protoxide of Molybdenum* (MoO).—*Molybdous oxide.* Obtained in the anhydrous form by the action of nascent hydrogen, and in the hydrated condition on adding ammonia to a solution of the protochloride. In the latter state it is soluble in solution of carbonate of ammonia but not in the carbonates or hydrates of potash or soda. Both varieties are of a black colour.

2. *Binoxide of Molybdenum* (MoO_2).—*Molybdic oxide.* Formed when molybdate of ammonia is strongly ignited in a covered crucible. The residue should be washed with caustic potash to remove any molybdic acid. Its colour is usually dark brown, but purple in direct sunshine. It is to a certain extent soluble in water; the solution sometimes gelatinises spontaneously. The salts of binoxide of molybdenum are red when hydrated, but in the anhydrous state are almost black. An olive green oxide, and a blue oxide of molybdenum have been described, but they are now known to be mixtures of the binoxide with molybdic acid.

3. *Molybdic acid* (MoO_3), is generally obtained by roasting the bisulphide, at a low red heat, in clay basins, but M. Brunner recommends that the pulverised mineral should be first mixed with an equal volume of quartzose sand, and the mass then roasted in a platinum capsule until it has acquired a lemon-yellow colour. After cooling, the molybdic acid is extracted by exhausting the product with ammonia. The residue from the evaporation of the ammoniacal solution is heated to low redness to expel ammonia, when molybdic acid remains as a pale buff-coloured powder. At a very high temperature molybdic acid volatilises and condenses on cool surfaces in brilliant transparent needles. Molybdic acid combines with bases to form neutral and acid salts called *molybdates*.

Molybdate of ammonia is sometimes used for detecting and even estimating phosphoric acid. It is best prepared by dissolving, with the aid of a gentle heat, two parts of pure molybdic acid and one of tartaric acid in fifteen of water and afterwards adding ten parts of ammonia (sp. gr. 0·97) and fifteen of nitric acid. The whole is heated to ebullition in a porcelain basin, when about one fifteenth of the molybdic acid will precipitate, and must be separated by filtration. The solution is then ready for detecting phosphoric acid, with which it gives a yellow crystalline precipitate of phospho-molybdate of ammonia.

Molybdenum and *sulphur* combine in three proportions and form *bisulphide of molybdenum*, (MoS_2) already noticed; *tersulphide of molybdenum*, or *sulpho-molybdic acid*, (MoS_3) precipitated on adding hydrochloric acid to a solution of a molybdate saturated with sulphuretted hydrogen; and *quadrisulphide of molybdenum* or *persulpho-molybdic acid*, (MoS_4). *Sulpho-molybdate of potash* (KS,MoS_3) crystallises in magnificent iridescent crystals.

Molybdenum and *chlorine* form two distinct chlorides, namely, *protochloride* and *bichloride*, as well as several oxychlorides that appear to contain *terchloride* of molybdenum.

Protochloride of molybdenum ($MoCl$). Excess of hydrochloric acid is added to a concentrated solution of an alkaline molybdate and zinc then introduced. As soon as evolution of hydrogen commences, the liquid becomes of a blue colour, then reddish brown, and finally black. By adding ammonia to the resulting solution and redissolving the washed protoxide in hydrochloric acid, a more pure protochloride is obtained.

Bichloride of molybdenum ($MoCl_2$) is obtained in deliquescent crystals on evaporating a solution of the binoxide in hydrochloric acid. In appearance it resembles iodine.

The detection of molybdenum is best effected by producing the colours mentioned under protochloride of molybdenum. It is usually estimated in the form of bisulphide, which contains 58·97 per cent. of metal.

MOLYBDIC ACID. [MOLYBDENUM.]

MOMENT. The moment of a force with respect to a point or line about which it *tends* to produce rotation, is "the product of the force and the perpendicular drawn from the point or line upon the *direction* of the force. If P be the force, and p the perpendicular, the moment of P is $P \times p$.

MOMENTUM, or MOMENT. This word has been used in various senses. It simply means a motion, the word *momen*, from *movimen*, being found in several ancient authors. *Momentum* was originally one rapid motion, whence it came to be used for a very short time; whence our word *moment*, which, in common life, means an indivisible instant of time. Thus an effect which requires a single second to produce it would not be properly momentary. But the word has passed into mechanics in its original sense of motion, and is used to signify the amount of an effect of motion, actual or conceivable. Thus we have one use in the article VIRTUAL VELOCITIES, another in LEVER, a third in MOMENTUM OF INERTIA, and a fourth, the most common of all, which we proceed to explain in this article.

The English synonym of this fourth sense is "quantity of motion," and we may observe that in this sense it is most usual, in our language, to adopt the Latin form *momentum*, instead of the abbreviation *moment*. It is impossible to give an actual definition of momentum, in simple terms: but the conception is obtained by those who observe that the effects produced by *matter* in *motion* (both notions are necessary) may be augmented either by giving the same motion to more matter, or greater motion to the same matter. Imagine a BALLISTIC PENDULUM, and suppose a bullet of two pounds weight to strike it with a velocity of 100 feet per second. The same oscillation which is thus produced, may, it is found, be produced by a bullet of one pound weight striking with a velocity of 200 feet. The same effect being produced in both cases, though by different quantities of matter and different velocities, there is something which we may assert to be unaltered by the substitution of the smaller bullet with the larger velocity. This something is the momentum, or quantity of motion, a notion of a cause which is asserted to be the same when effects are the same. This mere definition would be useless except in connection with principles observed or deduced, by which it may be applied. That there is a reality in connection with it, all who know the difference between light and heavy, as these words are frequently used, are well aware. A heavy blow, for instance, does not mean a blow with a heavy body: thus the fall of a poker may give a light blow, while that of a book of one-tenth part of its weight may give a heavy one. The difference in these cases is that of momentum.

The velocity remaining the same, the momentum or quantity of motion increases with the mass moved; and the mass remaining the same, the momentum increases proportionally to the velocity communicated. But the peculiar proposition on which the utility of the term and the notion depends is this, that in all mechanical effects produced by matter in motion, a diminution of the mass may be compensated by a proportionate increase of the velocity: that is, M being the number of units of mass, and V of velocity, as long as the product of M and V remains the same, the effect produced is the same. Thus in the preceding instance $M \times V$ is 2×100 in the first case, and 1×200 in the second. And as long as $M \times V = 200$, the same effect will be produced.

This product, MV, is the measure of the momentum, and is generally called the momentum itself. Here (as in MASS) tacit reference is made to a unit of momentum: the equation

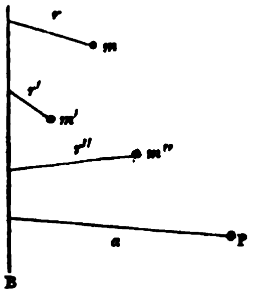
$$\text{Momentum of M with velocity } V = M \times V$$

implies that a unit of momentum is that produced by a unit of mass moving with a unit of velocity.

When the body moves under the action of a continually applied force, its *momentum* is now often expressed by the term *dynamical effect*, by which we mean the effect of a force with reference to its time of action. Thus if a force of 1 lb., acting for one second, produce a certain dynamical effect which we may assume to be *unity*: then the dynamical effect produced by P lbs. acting for t seconds will be $P.t$. Now let W be the weight of the body: M its mass: V its velocity: f the rate of acceleration due to P [3rd Law of Motion]. Then $P : W = f : g$: hence $P = \frac{W}{g}.f$; hence dynamical effect $= P.t = \frac{W}{g}.ft = MV$.

MOMENTUM, or MOMENT OF INERTIA. Let us conceive a system of bodies possessing weight, and immovably attached to a fixed axis, round which the whole system can turn. It is known from experience, as well as deducible from the laws of motion, that the nearer the bodies are placed to the axis, the more rotatory motion may be communicated by a given force. The *moment of inertia* is a name given to a mathematical function of the masses in the system and of their positions with respect to the axis, on the magnitude of which the rotatory motion produced by a given pressure, acting for a given time, depends. This function is the sum of the products made by multiplying the number of units in each mass by the number of units in the square of its distance from the axis. Thus, if m, m', m'', &c., be the masses of material points situated at the distances r, r', r'', &c., from the axis, the moment of inertia is $mr^2 + m'r'^2 + m''r''^2 + \&c.$ If the body be a continuous solid, and if dm be one of the elements of the mass, at a distance r from the axis, the moment of inertia is then $\int r^2 dm$, the integration being made throughout the whole extent of the solid.

Let AB be the axis, and let a pressure be communicated to the system at the point P, and such as would, were a mass P placed there, cause the system which consists of that single mass only to revolve with a velocity v, being at the distance a from the axis. The momentum of this velocity is Pv. Let the system of m, m', and m'', in consequence of this pressure, begin to revolve with an angular velocity θ (measured in theoretical units. [ANGLE.] The consequence is, that m, m', and m'' begin to revolve with velocities $r\theta$, $r'\theta$, and $r''\theta$, and momenta $mr\theta$, $m'r'\theta$, $m''r''\theta$. Now, if pressures, which would just prevent this motion in the same time as the applied pressure generated it, were applied in the opposite direction, the three pressures so applied would counterbalance the pressure at P. But [MOMENTUM] the pressures which in the same time produce motions are to one another as the momenta produced, so that if $C.Pv$ represent the pressure at P, those applied in the contrary direction at m, m', and m'', are $Cmr\theta$, $Cm'r'\theta$, and $Cm''r''\theta$. But the first acts perpendicularly at the extremity of the arm a, the others at the arms r, r', and r''. Hence $Cmr\theta.r + Cm'r'\theta.r' + Cm''r''\theta.r'' = CPv.a$ or $C(mr^2 + m'r'^2 + m''r''^2)\,\theta = CPva$.

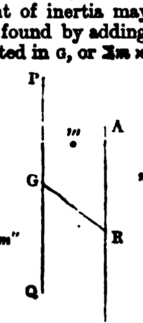


$$\therefore \theta = \frac{Pva}{mr^2 + m'r'^2 + m''r''^2}$$

the denominator of which is what has been called the moment of inertia of the system. Hence it follows that the communication of a given pressure at a given distance from the axis of rotation will cause an angular velocity which is inversely as the moment of inertia: if the masses or their distances were increased in such a way as to double the moment of inertia, the angular velocity produced by a given pressure would be only the half of what it would have been before the change.

The moment of inertia may be represented by Σmr^2 (sum of all the terms of the form mr^2), and the whole mass by Σm. Let k be such a distance that, if the whole mass were concentrated at that distance, the moment of inertia would not be altered: that is, let $\Sigma m \times k^2$ be $= \Sigma mr^2$. Then k is what was called the *radius of gyration*. [GYRATION.]

The property which is most important in the actual determination of moments of inertia by the integral calculus is one in virtue of which the moment may be found with respect to any axis when it is known with respect to a parallel axis passing through the centre of gravity. Let PQ be an axis passing through G the centre of gravity, and let AB be another axis parallel to PQ and distant from it by GR or h. Then, whatever the moment of inertia may be when PQ is the axis, that with respect to AB is found by adding the moment of inertia of the whole system concentrated in G, or $\Sigma m \times h^2$. That is



$\Sigma mr^2 = \Sigma m\rho^2 + \Sigma m \times h^2$ where $\Sigma m\rho^2 =$ moment of inertia of the system with respect to PQ.

Hence it appears that of all axes parallel to a given axis the moment of inertia is least for that axis which passes through the centre of gravity; so that, *cæteris paribus*, the greatest motion is produced by a given force when the axis passes through the centre of gravity. Of all the axes which pass through the centre of gravity there are three, each at right angles to the other two, which possess remarkable properties, and are called *principal* axes. [ROTATION.]

From what has been said it may easily be supposed that the moment of inertia is as important in the consideration of rotatory motions as the rectangle in mensuration. We shall see a further use of this function in OSCILLATION, and also a practical mode of finding the moment of inertia.

MOMORDICA ELATERIUM, Wild Cucumber; called in the last edition of the 'London Pharmacopœia' by the name given to it by L. Claude Richard, *Ecbalium officinarum*, a name more appropriate than *Elaterium*, which merely means any very active purgative, while *Ecbalium* refers to the remarkable power the fruit of this plant possesses of projecting the seeds along with a thin juice out of the capsule or pepo when ripe. Hence its familiar name of "squirting cucumber." It is an annual, native of the south of Europe, but also cultivated at Mitcham, near London. The unripe pepo and the juice are officinal. A very small quantity, less than a quarter of a grain, of the dried pepo will act powerfully as a hydragogue purgative. But the juice, called extract of elaterium, yields a principle called elaterin, or momordicine, also termed elatin. This is the active principle, and is very potent. The twentieth part of a grain is often sufficient to excite active purging: rarely should more than the tenth part of a grain be given, and every precaution should be used to avoid prostration, such as not repeating the dose till an interval of one or two days, supporting the strength with beef-tea, surrounding the abdomen with a flannel belt or bandage, to be tightened after each action of the bowels, and if necessary giving at the same time, unless contra-indicated, brandy or porter. Even the juice or the vapour of it may be absorbed through the skin, and cause violent vomiting and purging.

The *Momordica operculata*, Linn., a plant in South America, one of the bitterest in the world, has, according to Dr. Hancock, similar properties.

MONACHISM (from the Greek *μόνος*, alone; whence *μονάζειν*, to live alone; and *μοναχὸς*, a solitary, or a monk). In this its proper and original signification of a solitary, a monk may be considered as only another name for anachoret, or anchoret (in Greek, *ἀναχωρητὴς*), that is, a person who withdraws from society, a recluse; or for an eremite, corrupted into hermit (in the same way as the old and more correct ethnick has been corrupted into heathen), in Greek, *ἐρημίτης*, that is, a dweller in a desert or solitude.

The practice of retiring from the world for mortification or pious contemplation has been in use from time immemorial in the Brahminical and other religions of the East, and was known even among the Jews long before the birth of Christianity. We need mention only the instance of the prophet Elijah, to whom Roman Catholic writers indeed are fond of referring as the founder of monachism. An example of still more venerable antiquity is afforded by the Nazarites, male and female, described in the sixth chapter of the Book of Numbers, whose "vow of separation," however, lasted only for a certain fixed time.

In the earliest days of Christianity, many of the converts to the new religion, in their ambition to signalise themselves by extraordinary piety, adopted a remarkable severity of life and strictness of religious observance, whence they came to be known by the name of ascetics (in Greek *ἀσκηταὶ*), that is, literally, exercisers. Another name by which they are sometimes spoken of by the early ecclesiastical writers is spoudæi (*σπουδαῖοι*), that is, zealots. The connection of these ascetics with the description of persons afterwards called monks has been a subject of much disputation, the admirers and champions of the monastic system in general asserting the identity of the monks and ascetics, and their opponents maintaining that asceticism, as it existed in the primitive church, and monachism, as it sprung up in a later age, were two things wholly distinct. The truth appears to be that the early ascetics were certainly not universally, nor perhaps even generally, monks or solitaries; but still a separation, more or less rigid, from social life was one obvious mode of mortification and devotional abstraction, and one that was undoubtedly practised by some of the ascetics, though most probably without anything resembling the vows and other methodical restrictions which make part of monachism in its mature state. The ascetics themselves, it may be here observed, are commonly derived from the Jewish sect of the Therapeutæ, or Essenians, who inhabited the banks of the lake Mareotis, in the delta of Egypt, and who, having previously cast off much of the ancient reverence of their nation for the Mosaic law, had embraced Christianity in great numbers very soon after its promulgation. "The austere life of the Essenians," says Gibbon, "their fasts and excommunications, the community of goods, the love of celibacy, their zeal for martyrdom, and the warmth, though not the purity, of their faith, already offered a very lively image of the primitive discipline." ('Decline and Fall,' chap. 15.) And in a note, after admitting that Basnage, in his 'Histoire des Juifs,' has demonstrated, in spite of Eusebius and a crowd of modern Roman Catholics, that the Therapeutæ were neither Christians nor monks; he adds, "It still remains probable that they changed their name, preserved their manners, adopted some new articles of faith, and gradually became the fathers of the Egyptian ascetics." Afterwards (chap. 37), he seems distinctly to represent the ascetics as the fathers of the monks.

It is admitted on all hands that the immediate founders of monachism were two Egyptians, named Paul and Anthony. St. Jerome calls the former the author of that mode of life, the latter its illustrator—"hujus vitæ auctor Paulus, illustrator etiam Antonius." (Hieron., 'Ep. 22, ad Eustoch.,' c. 16.) Paul is designated the Thebæan. An account of St. Anthony, as he is styled, and of the progress of the monastic system during his life, which extended from A.D. 251 to A.D. 356, has already been given under his name. [ANTHONY, ST., in BIOG. DIV.] We shall only note here that the first monastic community is said to have been established at Faioum, near Aphroditopolis, in the Thebais of Egypt, about the year 305 or 306, that is, after the cessation of the persecutions which had originally driven Anthony, Paul, and others to the deserts. Strictly speaking, however, this and other monasteries appear to have been founded rather by Anthony's disciples, and in obedience to the spirit which his example had diffused, than directly under his own superintendence.

Of these disciples, the most eminent was Pachomius: if the Decian persecution and Anthony gave rise to monachism, monasteries owe their origin to Pachomius and the peaceful times of Constantine. The ancient writer of the 'Acta Pachomii' makes Anthony acknowledge this himself in the following speech to one of the disciples of Pachomius:—"When I first became a monk, there was as yet no monastery in any part of the world where one man was obliged to take care of another, but every one of the ancient monks, when the persecution was ended, exercised a monastic life by himself in private. But afterwards your father Pachomius, by the help of God, effected this." The other most celebrated early propagators of monachism are Hilarion, another disciple of Anthony, who carried the system into Palestine, about A.D. 328; St. Athanasius, bishop of Alexandria, who brought it to Rome, A.D. 340 [ATHANASIUS, in BIOG. DIV.]; Eustathius, bishop of Sebaste, or Sebastia, by whom it was soon after extended to Armenia and Paphlagonia; St. Basil, who established it in the province of Pontus, A.D. 360 [BASIL, in BIOG. DIV.]; and St. Martin, bishop of Tours, by whom it was, about A.D. 370, introduced into Gaul, whence it is generally supposed to have been imported into the British Isles by Pelagius, about the beginning of the fifth century.

At first all the communities of monks followed the rule of Pachomius, and therefore they were not distinguished into various orders, as in later times, but took their names from the places where they were established, as the monks of Mount Scethis, of Tabenne, of Nitria, of Canopus, &c. But besides the monks that lived in communities, and who were called from that circumstance *Cœnobitæ*, or sometimes *Synoditæ*, there were for some ages divers other species, which the ecclesiastical antiquarians have taken much pains to distinguish. Some lived, although in the same district of the wilderness, yet all in separate caves or cells, and without any association or common government, in which case the collection of hermitages was called a *Laura*, according to Epiphanius. Another sort are described by Cassian under the name of *Sarabaitæ*, and were called by the Egyptians *Remboth*, according to St. Jerome, who says that they lived two or three together, without any rule, but each after his own fashion, taking up their abode for the most part in cities and fortified stations (*castellis*). In other respects he gives a very bad account of them: although they were wont to contend with each other, he says, in extraordinary feats of fasting, yet at other times they would indulge to as much excess in riotous festivity; all things about them were affected; loose gloves (manicæ), puffed-out boots (caligæ follicantes), coarse clothes, frequent sighing, much visitation of the young women, violent inveighing against the clergy. In short, concludes Jerome, they are the pests and banes of the church. Another species of these early monks or solitaries were those called Stylitæ, that is, pillar saints (from *στύλος*, a pillar), the founder of whom was one Simeon, a Syrian shepherd, who having, in A.D. 408, when he was only thirteen years old, left his flocks and joined a monastic community, afterwards withdrew himself to a mountain about thirty or forty miles east from Antioch, and there, confining himself by a chain within a mandra, or circle of stones, proceeded at last to take up his residence on the top of a pillar, which was gradually raised from the height of nine to that of sixty feet. Simeon Stylites died A.D. 451, after having, it is said, existed for thirty years at the last-mentioned elevation in the air. "Habit and exercise," says Gibbon, "instructed him to maintain his dangerous situation without fear or giddiness, and successively to assume the different postures of devotion. He sometimes prayed in an erect attitude, with his outstretched arms in the form of a cross; but his most familiar practice was that of bending his meagre skeleton from the forehead to the feet; and a curious spectator, after numbering twelve hundred and forty-four repetitions, at length desisted from the endless account." This strange sort of piety, however, does not seem to have proved very contagious; among the few pillar saints, besides the contriver of the practice, whose names are recorded, the most famous are, another Simeon, styled the Younger, who is said to have occupied his airy watch-tower for sixty-eight years, and one Alypius, who left the bishopric of Adrianople for this other sort of episcopacy, and, it is affirmed, kept singing psalms and hymns between heaven and earth, at all hours of the day and night, for the full space of threescore years and ten, while a choir of monks and two choirs of virgins, seated on the ground below, lent the aid of their voices to swell the strain. About the beginning, or, as others think, about the middle, of the 5th century, a pious individual, named Alexander, set up a new fashion of monachism at Constantinople, the professors of which received the name of Accemetæ (in Greek, ἀκοιμηταὶ), that is, the watchers, or the sleepless, from their practice of dividing themselves into three classes, which took the performance of divine service in unbroken succession, so as to keep up a constant sound of devotion throughout the entire round of the twenty-four hours. The Accemetæ, sometimes called *Studitæ*, from Studius, a Roman nobleman, who became one of their society, and built a famous monastery for them, which, after him, was named *Studium*, were held in great estimation, and became very numerous at Constantinople. Alongside of the Stylitæ may be placed another description of fantastic enthusiasts, the Βοσκοὶ, or Grazing Monks, whose whim it was to live like the beasts of the field, inhabiting no houses, and eating neither bread nor flesh, but roaming about upon the mountains, as they continued without ceasing to make the wilderness resound with their hymns and psalms, and when it was time to eat, every man, taking his knife in his hand, proceeded to cut or dig for himself a dinner of herbs from the ground. Still another sort of old monks is mentioned, under the name of *Gyrovagi*, the Vagabond Monks, as the epithet may be translated. St. Benedict describes these as rambling about continually from province to province, getting themselves well entertained for three or four days at every cell they came to, mere slaves to their gluttonous appetites, and in all things worse even than the Sarabaritæ.

From this sketch it is evident that the institution of monachism had arrived at a state of very considerable corruption both in the Eastern and the Western churches, when St. Benedict arose to reform it, in the latter, in the earlier part of the 6th century. [Benedictine Order.] The Carthusians, Cistercians, Grandimontenses, Præmonstratenses, Cluniacs, &c., were all only so many varieties of Benedictines. The historians of monachism indeed reckon up twenty-three subdivisions of this order in all, distinguished only by such local or other specific appellations, and by some slight differences of habit and discipline. The innovations introduced by Benedict were of course longest in penetrating to the more remote corners of Christendom; and perhaps in no other part of Europe were they so long in being generally received as in the British Islands. Bede and others denominate the system which prevailed among the British monks before the arrival of St. Augustine in 597, the apostolic discipline; but it was probably merely the ancient rule of Pachomius. It is even disputed whether St. Augustine brought over with him the rule of St. Benedict; and at all events it is tolerably clear that the rule was not universally established in the British churches till its observance was enforced by St. Dunstan and his friend Oswald, in the reign of Edgar, after the middle of the 10th century.

Meanwhile in the Eastern church also monasteries and nunneries had been made the subject of legal regulation by a constitution of Justinian (Nov. 5), addressed to Epiphanius, the archbishop of Constantinople and œcumenic patriarch, in the consulship of Belisarius, A.D. 535. Persons were not permitted to assume the monastic habit till after a three years' probation, and the abbots (ἡγουμένοι) were required, during this time, to examine well into their life, conversation, and fitness for the monastic profession. On being approved, the candidates assumed the dress and tonsure. Both free persons and slaves were alike admissible into monasteries, and were received on the same footing in all respects. It seems that a man could leave his monastery and enter the world again, though it was considered sinful; but as all the property which he had not disposed of before entering the monastery (subject to some provisions for his wife or children, if he had any) became the property of the monastery on his entering it, if he chose to leave it he could not take with him or recover any part of his property. Celibacy and chastity were required of the monks, though at this time marriage was permitted to certain clerical persons, as singers and readers. Further regulations on the life of monks and nuns are contained in the 134th Novel.

In the earliest age of the monastic system, the monks were left at liberty as to many things which were afterwards made the subject of strict regulation by the laws either of the state or the church. St. Athanasius, in one of his epistles, speaks of bishops that fast, and monks that eat and drink; bishops that drink no wine, and monks that do; bishops that are not married, and many monks that are the fathers of children. Originally, too, monks were all laymen; and, although it gradually became more and more the common practice for them to take holy orders, it was not till the year 1311 that it was made obligatory upon them to do so by Pope Clement V. Nor was any vow of celibacy or any other particular vow formally taken by the earliest monks on their admission. It appears even that it was not unusual for persons to embrace the monastic life with the intention of only continuing monks for a few years, and for those who had spent some time in a monastery actually to return to the world.

The word nun, in Greek Νονὶς, in Latin *Nonna*, is said to be of Egyptian origin, and to signify a virgin. Another account is, that the original meaning of the Latin *nonna*, *nonnana*, or *nonnanis*, was a penitent. The Italians still use *nonno* and *nonna* for a grandfather and grandmother. Cyprian and Tertullian, in the latter part of the 3rd century, make mention of virgins dedicating themselves to Christ. Such a practice was indeed a natural mode of self-sacrifice, which had been familiar to all religions. Some of these ecclesiastical or canonical virgins, as they were called, appear already to have formed themselves into communities, similar to those of the monks; but others continued to reside in their fathers' houses. The progress of female monachism, however, from the rudeness and laxity of the first form of the institution, to the strict regulation which characterised its maturity, moved on side by side with that of male monachism.

Monasteries are called by the Greek fathers not only Μοναστήρια and Μοναὶ, but also sometimes *σεμνεῖα*, that is, holy places; *ἡγουμενεῖα*, the residences of the abbots, styled *ἡγουμένοι*, or chiefs; *μάνδραι*, inclosures; and *φροντιστῆσια*, places of reflection or meditation, that being one of the purposes to which they were very early applied.

The three vows of chastity, poverty, and obedience, are taken by all monks and nuns at their admission. All, both male and female, likewise receive the tonsure, like all the ecclesiastics of the Romish church. In all the orders the candidate for admission must first undergo a noviciate, which varies from one to three years. The age at which novices may make profession differs in different countries; but the rule laid down by the council of Trent only requires that the party, whether male or female, should be sixteen. It is scarcely necessary to add, that in the modern constitution of monachism, the vows and status of a professed person, as indeed of all ecclesiastics, are by the law of the Roman church for life and indelible.

The greatest revolution by which the history of monachism has been marked since the establishment of the rule of St. Benedict, was the rise, in the beginning of the 13th century, of the Mendicant Friars. Of these an account has been given under the word Friars: and further particulars will be found under the names of the several orders.

The general dissolution of monastic establishments was one of the first consequences of the Reformation in our own and all other countries that separated from the Romish church. There are however a few Protestant monastic establishments in some parts of Germany. Even in some Roman Catholic countries, especially in Germany and France, the number of these establishments has been greatly reduced within the last fifty or sixty years, and the wealth and power of those of them that still exist most materially curtailed. The reform of the German monasteries was begun by the emperor Joseph II.; those of France were all swept away at the commencement of the first Revolution; but some of them were set up again, though with diminished splendour, after the restoration of the Bourbons. Since the relaxation of the penal laws, several Roman Catholic nunneries have been erected in England and Scotland, as well as in Ireland. Monks and nuns of all descriptions still swarm in Italy, and in the countries of South America lately subject to the Spanish and Portuguese crowns; in Spain and Portugal monasteries were suppressed by the Cortes, during the war against Bonaparte: but many of them have been since restored, though much of their property has been sold and applied to national purposes. Even in modern times we still hear occasionally of the institution of a new order of monks. One, called the Congregation of the Blessed Virgin Mary, was established by the late Pope Leo XII., in 1826.

MONARCHY, from the Greek *μοναρχία*, a word compounded of *μον,ός*, "alone," and the element *ἄρχ,ω*, "govern," and signifying the "government of a single person." The word *monarchy* is properly applied to the government of a political community in which one person exercises the sovereign power. [Sovereignty.] In such cases, and in such cases alone, the government is properly styled a monarchy, and the supreme ruler is properly styled a monarch. Examples of monarchy, properly so called, are afforded by many Oriental governments, both in ancient and modern times, by the governments of France and Spain in the last century, and the existing governments of Russia, Austria, and France.

But since monarchs have in many cases borne the honorary title of *βασιλεὺς*, *rex*, *re*, *roi*, *könig*, or *king*, and since persons so styled have, in many states not monarchical, held the highest rank in the government, and derived that rank by inheritance, governments presided over by a person bearing one of the titles just mentioned have usually been called *monarchies*.

The name *monarchy* is however incorrectly applied to a government, unless the king (or person bearing the equivalent title) possesses the entire sovereign power; as was the case with the king of Persia (whom the Greeks called "the great king," or simply "the king"), and in more recent times with king Louis XIV., called by his contemporaries the *Grand Monarque*.

Now a king does not necessarily possess the entire sovereign power; in other words, he is not necessarily a monarch. Thus the king has shared the sovereign power either with a class of nobles, as in the early Greek states (Müller's 'Dorians,' b. iii., c. 1), or with a popular body, as in the Roman kingdom, in the feudal kingdoms of the middle ages, and in Hungary till the 18th century, and modern England, Holland, Belgium and Sardinia. The appellation of *monarch* properly implies the possession of the entire sovereign power by the person to whom it is affixed. The title of *king*, on the other hand, does not imply that the king possesses the entire sovereign power. In a state where the king once was a monarch, the kingly office may cease to confer the undivided sovereignty; and it may even dwindle into complete insignificance, and become a merely honorary dignity, as was the case with the ἄρχων βασιλεὺς at Athens, and the *rex sacrificulus* at Rome. (Creuzer's 'Abriss der Römischen Antiquitäten,' § 133.)

In Sparta there was a *double* line of hereditary kings, who shared the sovereign power with some other magistrates and an assembly of citizens. The government of Sparta has usually been termed a republic, but some ancient writers have called it monarchical, on account of its kings; and Polybius applies the same epithet to the Roman republic, on account of its two consuls. ('Philological Museum,' vol. ii., p. 49, 57.)

States which were at one time governed by kings possessing the entire sovereign power, and in which the king has subsequently been compelled to share the sovereign power with a popular body, are usually styled *mixed monarchies* or *limited monarchies*. These expressions mean that the person invested with the kingly office, having once been a monarch, is so no longer; and they may be compared with such expressions as νᾶες ἄναες, which occur in the Greek poets.

Governments are divided into *monarchies* and *republics*; and therefore all governments which are not monarchies are republics. As we have already stated, a monarchy is a government in which one person possesses the entire sovereign power; and consequently a republic is a government in which the sovereign power is shared between several persons. [REPUBLIC.] These definitions of *monarchy* and *republic* however do not agree with existing usage; according to which, the popular though royal governments of England and Belgium, for example, are monarchies (namely, *mixed* or *limited* monarchies), not republics.

The popular usage of the terms in question, to which we have adverted, is mainly owing to three causes. 1. Kings not possessing the entire sovereign power have in many cases succeeded kings who did possess the entire sovereign power; in other words, kings not monarchs have in many cases succeeded kings who were monarchs. 2. Both in royal monarchies and in royal republics, the crown or regal title usually descends by inheritance. 3. Kings who are not monarchs usually affect the state of monarchs properly so called; they intermarry only with persons of monarchical or royal blood, and refuse to intermarry with persons of an inferior degree.

Governments such as those of England and Belgium are included by popular usage, together with republics, in the term "free or constitutional governments," as distinguished from pure monarchies, absolute monarchies, or despotisms.

According to the existing phraseology therefore, the use of the two terms in question is as follows:—

Monarchies are of two sorts, namely, *first*, pure, absolute, or unlimited monarchies, that is, monarchies properly so called; and *secondly*, limited, mixed, or constitutional monarchies, or monarchies improperly so called, that is, republics presided over by a king or kingly governments where the king is not sovereign.

Republics are states in which several persons share the sovereign power, and in which the person at the head of the governing body does not bear the title of king. Accordingly, Holland with a stadtholder, Venice with a doge, and England with a protector, are called republics, not monarchies. If the head of the Venetian aristocracy had been styled king instead of doge, and if his office had descended by inheritance instead of being conferred by election, Venice would have been called a monarchy, and not a republic. The only exception to this usage of which we are aware occurs in the case of Sparta, which is commonly called a republic, and not a monarchy, although it had hereditary kings. The reason of this exception probably is, that there being *two* lines of kings at Sparta, it was thought too gross an inaccuracy to call its government monarchical; though its government would have been called monarchical, if there had been only one king, in spite of the narrow powers which that king might have possessed.

MONASTERY. [MONACHISM.]

MONESIN. A non-azotised organic substance resembling saponin, found in the bark of the *Chrysophyllum glycyphlæum*.

MONEY is the medium of exchange by which the value of commodities is estimated, and is at once the representative and equivalent of such value.

Barter is naturally the first form in which any commerce is carried on. A man having produced or obtained more of any article than he requires for his own use, exchanges a part of it for some other article which he desires to possess. But this simple form of exchange is adapted to a rude state of society only, where the objects of exchange are not numerous, and where their value has not been ascertained with precision. As soon as the relations of civilised life are established in a community, some medium of exchange becomes necessary. Objects of every variety are bought and sold, the production of which requires various amounts of labour; these at different times are relatively abundant or scarce; labour is bargained for as well as its products: and at length the exchangeable value of things, in relation to each other, becomes defined, and needs some common standard or measure by which it may be expressed or known. It is not sufficient to know that a given quantity of corn will exchange for a given quantity of a man's labour, for their relative value is not always the same; but if a standard is established by which each can be measured, their relative value can always be ascertained as well as their positive value, independently of each other.

As a measure of value only money is thus a most important auxiliary of commerce. One commodity from its nature must be measured by its weight, another by its length, a third by its cubic contents, others by their number. The diversity of their nature, therefore, makes it impossible to apply one description of measure to their several quantities; but the value of each may be measured by one standard common to all. Until such a standard has been agreed upon, the difficulties of any extensive commerce are incalculable. One man may have nothing but corn to offer for other commodities, the owners of which may not have ascertained the quantity of corn which would be equivalent for their respective goods. To effect an exchange these parties would either have to guess what quantity of each kind of goods might justly be exchanged for one another, or would be guided by their own experience in their particular trades. Whenever they wanted a new commodity their experience would fail them, and they must guess once more. But with money all becomes easy; each man affixes a price to his own commodities, and even if barter should continue to be the form in which exchanges are effected, every bargain could be made with the utmost simplicity: for commodities of every description would have a denomination of value affixed to them, common to all and understood by everybody.

But however great may be the importance of money as a measure of value in facilitating the exchange of commodities, it is infinitely more important in another character. In order to exchange his goods it is not sufficient that a man should be able to measure their value, but he must also be able to find others who, having a different description of goods to offer as an equivalent, are willing to accept his goods in exchange, in such quantities as he wishes to dispose of. Not to enlarge, however, upon the obvious difficulties of barter, which have been sufficiently indicated under BARTER, it will suffice to observe that all its difficulties are removed if some one commodity can be discovered which represents a certain amount of labour, and which all persons agree to accept as an equivalent for the products of their own industry. If such a commodity be found, it is no longer necessary for men to exchange their goods directly with each other; they have a medium of exchange, which they can obtain for their own goods, and with which they can purchase the goods of others. This medium, whatever it may be, is Money.

When money has assumed the character of a medium of exchange and equivalent of value, the cumbrous mechanism of barter gives place to commerce. But what must be the qualities of an article which all men are willing to accept for the products of their own labour? It is now no longer like a weight or measure, the mere instrument for assessing the value of commodities; but, to use the words of Locke, "it is the thing bargained for as well as the measure of the bargain." A bargain is complete when money has been paid for goods; it has no reference to the price of other goods, nor to any circumstance whatever. One man parts with his goods, the other pays his money as an absolute equivalent. But though money as a medium of exchange thus differs from money as a mere standard of value, yet in both characters it should possess, if it be possible, one quality above all others—an invariable equality of value at all times and under all circumstances. As a measure of value it is as essential that it should always be the same, as that a yard should always be of the same length. And unless, as a medium of exchange, its value be always the same, all bargains are disturbed. He who gives his labour or his goods to another in exchange for a delusive denomination of value instead of for a full equivalent which he expects to receive, is as much defrauded as one who should bargain for a yard of cloth and receive short measure.

But however desirable may be the invariableness of money, complete uniformity of value is an impossibility. There is no such thing as absolute value. All descriptions of measures correspond with absolute qualities, such as length, weight, and number, and may be invariable. But as value is a relative and not an absolute quality, it can have no invariable measure or constant representative. The value of all commodities is continually changing; some more and some less than others. Their real value depends upon the quantity of labour expended upon them; but temporary variations in their exchangeable value are caused by abundance or scarcity—by the relations which subsist between supply and demand. No commodity yet discovered is exempt from the laws which affect all others. If precisely the same quantity of labour were required for a long series of years to produce equal quantities of any commodity, its real value would remain unchanged; but if it were at the same time an object of demand amongst men, variations in the proportion between its supply and the demand for it would affect its exchangeable value. It follows therefore, that to be an invariable standard, money must always be produced by the same amount of labour, and in such quantities as shall constantly bear the same proportion to the demand for it.

But even if any description of money could be invented which possessed these extraordinary qualities, the value of all other articles would still be variable, and thus its representative character would be disturbed. At one time, for example, a given denomination of money will represent a certain number of bushels of wheat; at another time the same money, unchanged in real value or demand, will represent a much greater number. Every application of machinery, every addition to the skill and experience of mankind, facilitates production, and by saving labour reduces the real value of commodities. Their value is also liable to temporary depreciation from other causes, from too abundant a supply, or from an insufficient demand. But if money maintain the same value, in relation to itself, notwithstanding the diminished value of other articles, its proportionate value is practically increasing.

In all ages of the world, and in nearly all countries, metals seem to have been used, as it were by common consent, to serve the purposes of money. It is true that other articles have also been used, and still are used, such as paper in highly civilised countries, and cowrie shells in the less civilised parts of Africa; but in all some portion of the currency has been and is composed of metals. We read of metals amongst the Jews, the Chinese, the Egyptians, the Persians, the Greeks, the Romans. In the earliest annals of commerce they are spoken of as objects of value and of exchange; and wherever commerce is carried on they are still used as money. But as they were introduced for this purpose in very remote times, it is not probable that they were selected because their value was supposed to be less variable than that of other commodities. More than two thousand years ago, indeed, Aristotle saw clearly (but what did he not see clearly?[*]) that the principal use of metallic money was that its value was less fluctuating than that of most other substances ('Ethic. Nicom.' v. 5). But however clearly this great philosopher may have observed the true character of money, many ages after the circulation of metals, those who first used them were men engaged in common barter, who considered their own convenience and security without reference to any general objects of public utility. They must have used metals not as a standard of value. but as an article of exchange, which facilitated their barter. All metals are of great utility and have always been sought with eagerness for various purposes of use and ornament: but gold and silver are especial objects of desire. Their comparative scarcity, the difficulty and labour of procuring them, their extraordinary beauty, their singular purity, their adaptation to purposes of art, of luxury, and display; their durability and compactness; must all have contributed to render them most suitable objects of exchange. They were easily conveyed from place to place; a small quantity would obtain large supplies of other articles; they were certain to find a market; none would refuse to accept articles in payment which they could immediately transfer to others: and thus gold and silver naturally became articles of commerce, readily exchangeable for all other articles, before they were circulated as money, and were acknowledged as such by law and custom.

The transition of the precious metals from the condition of mere articles of exchange, amongst many others, to that of a recognised standard of value by which the worth of all other articles was estimated, was very natural. Merchants carrying their wares to a distant market would soon find it necessary to calculate the quantity of gold and silver which they could obtain, rather than the uncertain quantities and bulk of other commodities. They would not know what articles it would be prudent to buy until they reached the market and examined their quality and prices: but a little experience would enable them to predict the quantity of gold and silver which would be an equivalent for their own merchandise. Merchants from different parts of the world, meeting one another in the same markets, and finding the convenience of assessing the value of their goods in gold and silver, would begin to offer them for certain quantities of those metals, instead of engaging, more directly, in bartering one description of goods for another; and thus, by the ordinary course of trade, without any law or binding custom, the precious metals would become the measure of value and the medium of exchange.

But when gold and silver had attained this position in commerce, they were not the less objects of barter; nor were they distinguishable in character from any other articles of exchange. They were weighed, and being of the required fineness, a given weight was known as a denomination of value, but in the same manner only as the value of a bushel of wheat may be known. In the earliest ages gold and silver seem to have been universally exchanged in bars, and valued by weight and fineness only. The same custom exists at the present day in China. There is no silver coinage, "but the smallest payments, if not made in the copper *tchen*, are effected by exchanging bits of silver, whose weight is ascertained by a little ivory balance on the principle of the steelyard." (Davis's 'China,' c. 22.)

Notwithstanding the ease with which gold and silver are divided into the smallest portions, each of which is of the same intrinsic purity and value as the others, the trouble of weighing each piece, and the difficulty of assaying it in order to detect alloys of baser metals, render these metals in bars, or other unfashioned forms, extremely imperfect instruments of exchange, especially when they are used in small quantities. However accurately they may be weighed, it requires considerable skill and labour to assay them, which in small pieces would scarcely be repaid. Even in large quantities the difficulty of assaying their fineness, in countries which have made considerable advances in the arts, is greater than might be expected. To obviate this difficulty coinage was introduced, by which portions of gold, silver, copper, and other metals have been impressed with distinctive marks, denoting their character, and have become current under certain denominations, according to their respective weight, fineness, and value. These coins have always been issued by the government of each country as a guarantee of their genuineness; and the counterfeiting of them has been punished as a serious offence against the state.

In rich countries these three metals of gold, silver, and copper, or of a mixed metal, such as bronze, are very convenient substances for the manufacture of coins, on account of the differences in their relative value. Gold coins, containing a high value in small compass, are convenient for large payments, silver coins for smaller payments, and copper or bronze coins for those of the lowest value; while all the larger coins are multiples of the smaller. These several descriptions of coin serve the ordinary purposes of trade sufficiently well: they are universally received as money within the country in which they circulate, and the principal part of all payments of moderate amount is made in them. But payments of large amounts cannot conveniently be made in coins of any metal; and in this and other countries paper money and various forms of credit have been used as substitutes. Of these we shall speak presently; but it will first be necessary to consider the suitableness of gold and silver coins as standards of value.

Coins made of these metals are not exempt from the laws which govern the prices of other commodities. They have accordingly varied in their own value in successive periods, and are at no time secure from variation. In the 16th century new mines of extraordinary richness were opened in America, from which a large amount of the precious metals was poured into Europe; this gave a great stimulus to commerce and industry, and a material change took place in the relative prices of these metals, and other commodities.

The discovery of the gold deposits in California has brought such considerations into the class of debateable questions in our own day. The distinguished political economist, M. Michel Chevalier, in his lectures before the College of France, published in 1850, predicted that if Russia and California continued to produce gold at the rate they were then doing, the value of gold would be ultimately reduced by five-sixths, or even nine-tenths. He admits, however, that the fall, though rapid at first, would be greatly retarded by the adaptability and greater beauty of gold for purposes of ornament or use, for which silver is now used. This opinion, slightly modified, is repeated in his work 'On the probable Fall in the Value of Gold,' translated in 1859 by Mr. Cobden; and he attributes the little effect hitherto produced, even with the addition of the immense quantity imported from Australia, to the absorption of a large proportion of it by France in exchange for her silver. In these predictions, however, he is thought by some to overlook many material facts, the influence of which the experience of twenty years has in a great degree substantiated. The addition of gold or silver forms an addition to the world's capital, and this capital forms a fresh labour fund; such additions therefore give a great stimulus to increased industry, and the wages for this industry require and absorb a large though an indefinite quantity of the precious metals. M. Chevalier saw this to some extent, for he says ('La Monnaie,' p. 473), "that such an increase as was then taking place would compel England, for the purposes of her commerce, to increase ninefold the amount of her coined gold." The anticipated fall has not followed; the general increase of manufacturing industry, the exports from England in a few years mounting from 50,000,000*l.* to 130,000,000*l.*, has necessitated a corresponding increase in the sum distributed as wages, which has been accompanied by a great increase of imported articles for home consumption by the classes so benefited; the import of tea, for instance, increasing from 40,000,000 lbs. in 1838, to 75,000,000 lbs. in 1858. This again has occasioned a re-action not contemplated by M. Chevalier. China takes little except silver in exchange for her tea; the East Indies also require silver for their commodities, and in this way from 15,000,000*l.* to 20,000,000*l.* in silver are abstracted from Europe, which deficiency must be filled either with gold or silver from the various mines in work. Thus in the year 1859, the total quantity of gold and silver bullion imported into the United Kingdom was valued at 37,070,156*l.*; of which 20,370,901*l.* from the United States, Australia, and Russia, was probably gold; and 7,302,308*l.* from France, and 5,123,982*l.* from Mexico and South America, will probably represent the silver. The exportations amounted in value to 35,688,808*l.*, of which 10,384,371*l.* went to France, no doubt in gold to replace her abstracted silver; and 16,616,581*l.* to Egypt, for transmission to India and China, nearly all of which must have been in silver. The influx of the precious metals (for the produce of silver continues to be large) has had, as yet, little visible effect on the prices of commodities in general, and none whatever in the relative values of the two metals; at least none beyond the slight variations occasioned by the wants of commerce for the one or the other. Articles of consumption for food or clothing are not higher in price than before the gold discoveries. But it is impossible distinctly to assign the rise or the fall in prices to the influx of the precious metals, during a period when the operation of our new commercial system has unquestionably placed, not only agricultural produce, but articles of luxury, more within the reach of the majority of consumers. There may have been a continuous fall in the price of the necessaries of life under a large additional supply of Australian gold; and there may also have been a continuous rise, such as that of meat, from the greater stimulus to industry demanding more labourers, and therefore raising the rate of wages. Many variations in the price of products manifestly depend on their own scarcity or abundance, and not merely on the increase of gold. It is satisfactory to know that since the time of the Australian gold discoveries, the rise in the wages for labour has been more marked than the average rise in the price of commodities, enabling the labouring population not only to increase, but to consume more, and of a better quality, than they could previously, thus maintaining and extending the demand for, and the capability of employing, almost any fresh amount of the precious metals, whether silver or gold.

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[*] Many important principles of political economy, the discovery of which is attributed to Adam Smith and other modern writers, may be found in the works of Aristotle, expressed with wonderful precision and clearness. Mr. M'Culloch, for example, refers to Locke as the first who laid it down that labour is the source of value; but the same principle was affirmed by Aristotle in more than one part of his works, and more accurately than by Locke ('Ethic. Nicom.' v. 5). Again, he perceived, perhaps as distinctly as any other writer, the distinction between productive and unproductive labour ('Metaph.' ix. 8). As another example we would refer to his account of the origin of barter, its development into commerce, and the connection of the latter with the use of money ('Pol.' i. 6). And, lastly, any economist must be struck with his clear perception of the relations between a division of employments and the exchange of the products of labour (Ib. ii. 2).

There is a difficulty in deciding the question whether, or to what extent, the price of gold fell on the influx of gold at the end of the 16th century, or on the Californian and Australian discoveries in the middle of the 19th. By the Windsor tables, the price of wheat in England averaged about 34*s.* per quarter, from 1606 to 1625, sometimes however reaching as high as 58*s.* per quarter and sometimes sinking as low as 30*s.* It subsequently ranged, under Charles I., from 40*s.* to 44*s.* per quarter; a sum not widely different from the present prices. Wheat, taken in decennial averages from 1660 to 1860, has averaged only 49*s.* per quarter. But the rate of labour has permanently increased nearly cent. per cent., while at the same time many articles of luxury and convenience have become cheaper through the improvements in the means of production. These variations, like all of similar character, evidently depended on the abundance or the scarcity of harvests, unrelieved by an extended foreign commerce. Except in long averages, the prices of articles of consumption afford no proof of any alteration in the value of money. Potatoes or meal—oat, rye, or wheat meal—in Ireland, during the time of the potato-rot, or boots at the Australian diggings, may have fetched fabulous prices; but it is at once seen in these cases, that it is the exceptional circumstances, and not any real alteration in value, that has produced the difference. The general effect of an influx of the precious metals appears to have been to stimulate industry; this industry, represented largely by manual labour, had to be paid for; this, in its turn, enabled a much larger proportion of the population to consume more food, and of a better quality than previously, and rye-, oat-, and barley-bread, disappeared in England from the consumption even of the paupers.

Gold, after all, only represents labour. On the discovery of the riches of Peru and Mexico, they were found already accumulated, and were merely transferred to new possessors, without labour and with little risk. In the more recent discoveries, the produce has been the result of labour. This labour has been looked at as wonderfully profitable. In a few lucky instances it may have been so, but on the average it is doubtful whether the labour has not been sufficient to maintain the value of the gold; for if the labourer received high pay, he had to pay exorbitantly for the necessary means of his maintenance; and those who supplied him with those means, though they charged high, had to convey them to him at an immense expense, and under great difficulties, so that no great excess of profit was made by any one beyond what is gained by the early possession of a good market.

M. Chevalier predicts that the labourer will be a great ultimate sufferer from the continued influx of gold, and its consequent depreciation; because, he says, the price of labour, though it follows the price of articles of consumption, does so very slowly; and therefore, as the value of gold descends, and the comparative value of all other articles rises, he will never be able to maintain his relative position. This is in some degree to appear to overlook a truth which so experienced an economist as M. Chevalier cannot really have overlooked, that there is no absolute relation between the wages of labour and the price of commodities. If the influx of gold gives a stimulus to home industry —if the gold-digger of Australia becomes a new and profitable customer to the manufacturer of Britain—the increase in the demand for labourers causes a rise in wages which may be equal to, or even exceed, a rise in the price of commodities. But further—we must take into account the difference between the precious metals and articles of consumption. If a favourable season renders corn and cattle abundant, the increase of so much capital gives means for enlarged expenditure, promotes industry, tends to raise the rate of wages by the extended demand for labour, and so far resembles the effect produced by an increased supply of gold. But a falling-off in the supply of articles of consumption has no similarity with that of gold. A dearth not only suddenly raises the price, in a proportion far exceeding the actual deficiency, but by concentrating expenditure upon articles of necessity, checks or almost entirely stops industry. It is then the labourer suffers. What he needs has attained an exorbitant value, while what he has to offer in exchange, his labour, has lost its value from the want of means of employing it profitably. But no such effect could possibly follow from the total suspension for years of any supply of gold. There might be less stimulus to industry, but the gold which was sufficient before the supply stopped, would remain to be still employed in exchange; and this would continue unaltered for years. It is this property which renders gold so peculiarly the best standard of value.

Contemplating the ultimate depreciation of gold, the writer of the article in the 'Edinburgh Review' recommends the adoption of a system of corn averages. He proves very satisfactorily that any considerable depreciation in the value of gold, as money, would press with great and undue severity on all persons with fixed incomes, and on the labourer. The adoption of his suggestion, we believe, would rather increase than mitigate the evil; for depending on the seasons, there are few things necessarily subject, from the variation in both quantity and quality in successive years, to such large and sudden alterations as the price of corn. In the year ending Michaelmas, 1853, after the supply of gold had been much increased, the average price of wheat was 45*s.* 8*d.* per quarter; in the following year it was 73*s.* 1*d.*; and it continued as high, or somewhat higher, for the following two years; but in 1858, with all the fresh importations of gold, the average was only 46*s.* per quarter, and in 1859 only 43*s.*

As M. Chevalier and the Reviewer admit that in speaking of relative values, it is difficult to decide which rises and which falls, should we not select that article which suffers the least physical change, and is least dependent on the seasons? Gold is peculiarly such an article. Abstractedly, gold may be less valuable than iron, but from its beauty, and the difficulty and labour of procuring it, it has been accepted by all mankind as the representative of value. From its indestructibility, the amount remains unwasted, which is the case with few other articles; from its portability and intrinsic value it can be secured with less danger, and used with greater convenience, than most other materials; its value is therefore more likely to be fixed than anything else.

Both gold and silver are alike subject to the general law of demand and supply, and are therefore imperfect standards of value. If one be the standard independently of the other, it is liable to change in itself, and also in its relation to other commodities: if both be adopted as standards at the same time, they will not only each vary in themselves, and in relation to other commodities, but they will vary also in regard to each other. And thus another element of uncertainty is introduced into the coinage, which becomes still more imperfect as a standard.

But it is not customary for the state to allow coins to fluctuate in their legal value according to the circumstances which determine the market prices of gold and silver. Coinage does not merely authenticate the weight and fineness of a piece of metal, leaving it to find its own level in exchange for other commodities; but it attaches to it a definite value, by fixing the standard price of the metal as well as the weight and fineness of the coin. The object of this regulation is to maintain a greater equality in the standard; and as regards small fluctuations in the value of the precious metals, it will generally have that effect, at any rate for the country for which they were coined. But if any considerable disproportion should arise between the standard price of bullion and the market price, no such regulation can prevent a practical change in the standard. If the market price should become considerably higher than the standard price, the coins would be melted down for the sake of the profit arising from the difference. If it should become considerably lower for any length of time, the value of the coins, though nominally unchanged, would in fact be depreciated; for they would exchange for a less quantity of other commodities than they exchanged for before. And thus a currency composed exclusively of metals cannot be made an accurate standard of value by any expedients of law.

We may here remark, however, that a seignorage, or charge by government to cover the expenses of coinage, acts as a protection, within certain limits, against the melting of coins, because unless their value be depreciated by over-issue, the whole charge will be added to their value as coins, and will be lost when they are melted. For this amongst other reasons a seignorage should always be charged by the state.

There is yet another imperfection in coins as standards of value. Notwithstanding their natural durability, they are subject to continual wear, and must be gradually diminished in weight. They are also exposed to the fraudulent experiments of men whose trade it is to rob them of a portion of their weight by artificial wear. The value of coins is therefore certain to be continually depreciated by loss of weight, apart from any other causes of variation.

From all these circumstances it is evident that gold and silver coins have qualities inherent in them which render them necessarily imperfect standards of value, with whatever care and skill they may be regulated. But, in addition to these natural causes of imperfection, others have been artificially produced by erroneous or dishonest political expedients. There is no country perhaps in which the coinage has never been debased by the government. Debasement of coins was formerly a common artifice for increasing the revenue of states, and it has been effected in three different ways:—1. By diminishing the quantity of metal, of the standard fineness, in coins of a given denomination; 2. By raising their nominal value and ordaining that they shall pass current at a higher rate; and, 3. By debasing the metal itself, that is, by leaving the coin of the same weight as before, but reducing the quantity of pure metal and increasing the quantity of alloy. In all these ways have the coins of England been debased at different periods of our history; and to so great an extent were they debased by successive kings, that from the Conquest to the reign of Queen Elizabeth the total debasements of the silver coins have been estimated at 65 per cent. (Lord Liverpool, 'On Coins.') By expedients of an opposite character the standard of coins may be artificially raised; and the result of measures connected with the coinage of this country was, that in a period of 115 years, from the 1st James I. to the 1st George I., the value of gold coins, as compared with silver coins, was raised 39 per cent. (*Ibid.*) No further examples are needed to prove the inconstancy of coins as a standard, when they form the sole currency of a country.

But notwithstanding these imperfections, the convenience of gold or silver coinage, as money, has led to the universal adoption of one or the other, or of both conjointly, as the standard of value. The objections to a double standard have already been noticed, but throughout a long period of the history of this country we find gold and silver prevailing equally as standards. There appears to have been no public coinage of gold at the royal mints prior to the 41st Henry III. The gold pennies coined at that time were expressly declared not to be a legal tender, and never obtained a very general circulation. Silver was then the universal medium of exchange, and the people were unaccustomed to the use of gold as money: but as their commerce and riches increased, gold naturally became more convenient for large payments. The results of this progress became apparent in the reign of Edward III., who established a general circulation of gold coins, which, though partially introduced nearly a hundred years before, by Henry III., had not been continued by his successors. From this time gold and silver coins circulated together, and were both legal tenders. To what an extent their relative value varied at different periods, has already been noticed; but they were equally recognised by law as authorised standards of value in all payments whatever, until the year 1774, when it was declared by statute (14 Geo. III. c. 42) that, in future, silver coins should not be a legal tender in payment of any sum exceeding 25*l.*, except according to their value by weight, at the rate of 5*s.* 2*d.* an ounce. This was a temporary law, but was continued by several statutes until the year 1816, when the legal tender of silver coins was further restricted to payments not exceeding forty shillings (56 Geo. III. c. 68). And thus, as all large payments were made and calculated in gold coins, gold became the sole standard of value, so far as coinage alone was the real medium of exchange.

The expediency of adopting gold as the standard instead of silver, has been a question of much controversy amongst the highest authorities upon monetary affairs. It was the opinion of Locke, of Harris, and Sir William Petty (all great authorities), that silver was the general money of England, and the measure of value in its commercial dealings with other countries. Its general adoption for such purposes was urged as a proof of its superiority as money over gold; and of this opinion are some writers of high authority at the present day. On the other hand it has been argued, that the metal of which the chief medium of exchange is fabricated, should have reference to the wealth and commerce of the country for which it is intended; that copper or silver coins of the lowest denominations suffice for the convenience of a very poor country; but that as a country advances in wealth its commercial transactions are more costly, and require coins of corresponding value. As a matter of convenience this is undoubtedly true. Gold is the standard in England; silver is the standard in Holland and other countries; France has a double standard, silver and gold; and the comparative facility for effecting large payments in the current coins of those countries can admit of little doubt. Habit will familiarise the use of silver, and render a people insensible to its inconvenience; but it is certain that in England fifty sovereigns can be carried about in a man's waistcoat pocket, while in France the value of that sum in silver would weigh about 15 lbs. troy. The *fixed* price of gold, of the coinage standard of 22 carats fine to 2 of alloy, at the Mint or Bank of England is at the rate of 3*l.* 17*s.* 9*d.* per oz. There is no fixed price for silver; but the average on a long number of years is almost exactly 5*s.* The Mint coins one ounce of silver (Mint standard) into 5*s.* 6*d.*, and obtains therefore 4*d.* or 6*d.* on the ounce profit for coinage. For gold coinage it only charges a small seignorage; the Bank of England, by an arrangement with the Government, receiving gold at the fixed rate of 3*l.* 17*s.* 9*d.* per ounce (Mint standard), and returning it coined at the rate of 3*l.* 17*s.* 10½*d.* per ounce. The price of gold is therefore kept at a standard deviating only by 1½*d.* per ounce.

But the convenience of coin for a certain class of payments is a question quite distinct from that of its fitness for a standard of value. It is not necessary to exclude gold from the coinage because it is not adopted as the standard; it may be circulated as freely as the people desire to use it, while, instead of being the legal standard, its value may be calculated in silver. If silver be the standard, a large gold coinage may circulate at the same time for the convenience of larger payments, just as silver circulates for small payments where gold is the standard. In either case, however, that metal which is chosen by the state as the lawful standard governs all calculations and bargains, while the other metal merely conforms to its standard, and is subsidiary to it. But even if the relative convenience of gold or silver as a standard were the sole question, it could not be determined by the modes of effecting large payments only. All payments are calculated as easily in the coins of one metal as of another, in whatever form they may be actually effected. But by far the greater number of bargains are made for articles of small value. It is in silver and copper that the consumption of all commodities is mainly paid for. The wages of the country are paid and expended in that form; and in that form the prices of nearly all the ordinary articles of daily use are calculated.

The fitness of a standard however cannot be determined solely by considerations of convenience; for we must chiefly regard its intrinsic qualities as a permanent measure of value. How shall uniformity of value be maintained as far as practicable in the money of a country? is the main question to be determined; and not, Which is the most convenient form in which to make bargains? In what medium shall the whole property of the country be valued, from one year to another. By what standard shall the relative value of all things be compared? How shall fluctuations be restrained in the value of this standard itself? These are the questions to be answered.

In favour of gold as a standard it is argued that being less extensively used for plate and other manufactures, it is less an article of commerce than silver, and is confined more specially to the purposes of money. On the other hand, it is contended that gold is used in large quantities for jewellery, watches, and decorative purposes, and that being a more costly material, its consumption in this affects its quantity and value to a greater extent than the use of plate affects the price of silver. And in this argument there is much weight, for it is estimated that the quantity of gold compared with the quantity of silver is as 1 to 50; and their relative value is as 1 to 15. (See 'Bullion Report,' 1810. Allen's Evidence.) Yet in a long series of years the relative prices of the two metals have not materially varied; but the fluctuation has been very much more in the price of silver than in the price of gold; a difference of 1*d.* an ounce in each being equal to a variation of 15 to 1 against the standard price of silver as compared with gold.

But it is not sufficient to consider the demand for the precious metals as articles of consumption only; they are suddenly sought for in large quantities for other purposes. If the exchanges be unfavourable to a country, its precious metals are in greater demand for exportation than its commodities; or if there be a foreign war, its metals are in demand for the payment of the troops and for the purchase of food and munitions of war, simply because of their ready convertibility. This applies with peculiar force to gold. It is because of its superiority as a medium of exchange and standard of value that it is taken.

If it should happen that one country has a large gold coinage in circulation in addition to all the bullion which is required for the purposes of commerce, while all the adjacent countries use a silver currency, and possess very little more gold than is necessary for its consumption, it is clear that whenever a large demand for gold arises, it must be directed to the country in which there is a gold currency. The gold in the other countries has, in fact, become higher in value from the increased demand, and so soon as the increased value makes it worth while, the gold in the country where it has not yet risen, will be immediately used by all others as a rich gold mine, whence abundance of metal without alloy, and assayed ready to their hands, may at once be grasped, without digging in the earth. No laws and no vigilance can restrain its export: as soon as it is wanted abroad, it disappears like water through a sieve. Whenever gold is wanted, the coinage of England, if there is not a sufficient supply of bullion, supplies it to those countries having a silver standard; while if England requires silver it is rapidly drained from those countries. The extent to which gold is exported when the foreign exchanges are unfavourable may be seen from the returns of bullion retained by the Bank at many different periods. We have already stated the large amount of silver obtained from France in 1859.

But it must be recollected that, independently of fluctuations in the prices of bullion, a diminution in the quantity of money circulating in a country raises the value of the remainder, and disturbs its relation to the prices of other commodities. It is in this form that the effects of an abstraction of gold must be felt rather than in the price of bullion; and though its influence upon prices is very injurious, the cause is not always perceptible. When paper money is added to gold and silver coin as part of the circulation, a country can always command a sufficient quantity of money; but the drain of its metals has an important influence upon the value of its circulating medium, and upon the operations of commerce.

But the precious metals, even gold, have an inconvenience from their bulk, the dangers of transit in large quantities, and the need of at least occasional assaying. In all commercial nations the use of paper money is almost imperative, and its convenience makes it in various respects desirable even in the internal trade of a country. Its value however as a medium of exchange is merely that it is a guaranteed representative of real value. This guarantee may be afforded by the issue of paper either immediately by a government, or by its delegated agents; and no paper can be kept up to its nominal value unless it is known to be readily convertible into real value at any time at the desire of the holder. The paper money of most of the continental states is at a considerable discount from not being so convertible, and the state itself does not receive it in payment of taxes or duties, for instance, at the full amount it nominally represents. Further information on this subject will be found in the articles BANK and BANKING; BILLS OF EXCHANGE; EXCHANGE; CURRENCY, &c.

Money, as a circulating medium, is either of metal coined for the purposes of commerce, usually stamped with the name and arms of the prince or state that directs it to pass current; or it is money of account, which may be considered with respect to coins as weights and measures with respect to goods, or as a mathematical scale with respect to maps, lines, or other geometrical figures. Thus moneys of account serve as standards of the value both of merchandise and of the precious metals themselves. It should, however, be remarked, that moneys of account, though they are uniform as a scale of divisions and proportions, yet they fluctuate in their intrinsic value with the fluctuation of the coins which they measure or represent.

The earliest currency of metal has been already treated of under COIN, together with the denominations, as far as they are known, of the different moneys current among the chief nations of antiquity, as well as some in our own country.

Several other of the more important coins, ancient and modern, have been already disposed of under their respective heads; we shall now lay before our readers as concise an account as possible of the money which forms the present, or has formed the recently existing, metallic currency of modern nations, taking them alphabetically:—

Albert's Dollar is a coin formerly known in Holland, with its half and quarter, at 50, 25, and 12½ stivers. The term is used also as a money of account at Libau and Riga. The intrinsic value of a metallic Albert's dollar was 4*s.* 4½*d.*

Altmichlic, a Turkish silver coin, no longer in use.

Ana, an East Indian coin, the 16th part of a rupee; worth about three halfpence.

Asper, a small Turkish money of account.—3 aspers = 1 para; 40 paras = 1 piastre.

August d'Or, a gold coin of Saxony, double, single, and half; reckoned at 10, 5, and 2½ rix-dollars. The august piece of 5 thalers was worth 16*s.* 5½*d.* It is now disused.

Bajoccho, or *Soldo*, a copper coin at Rome, formerly divided into 12 denarii, or 5 quattrini; worth about the third of a penny. There are also double and single bajocchelli, of 4 and 2 bajocchi. 100 bajocchi = 1 scudo romano.

Batzen, a base silver coin formerly used in Switzerland, and also in some parts of Germany. It was worth about 1½*d.* English.

Beshlik, a Turkish and Egyptian coin: worth, in Egypt, about 2*s.* 3½*d.*; in Turkey, 1*s.* 0½*d.* The beshlik in Syria is a mixed metal, and is worth about 10*d.*

Bit, or *Bitt*, a small coin in the West Indies, worth 5½*d.*

Candereen, a part of the currency of China, passing by weight; 1000 candereens = 1 tael, which is worth 6*s.* 7*d.*

Carlino, a small silver coin in the kingdom of Naples and in Sicily: it contains 10 grani, worth 4*d.* There are mezza-carlini, of half the value. In Piedmont the carlino was a gold coin: coined before 1785 it was of the assayed value of 5*l.* 18*s.* 8*d.*; subsequent to that year, 5*l.* 12*s.* 3*d.*; the half, &c., in proportion.

Carolin d'Or, or simply *Carolin*, a gold coin of Bavaria, Hesse-Darmstadt, and Würtemberg, now disused, value 20*s.* 6*d.*

Cash, a small coin in China, and India beyond the Ganges. It is the only coin used in China. It is not coined, but cast. It is composed of 6 parts of copper and 4 of lead; round, marked on one side, and rather raised at the edges, with a square hole in the middle. These pieces are commonly carried like beads on a string or wire. A tael in account of fine silver should be worth 1000 cash, or about 6*s.* 7*d.*; but, on account of their convenience for common use, their price is sometimes so much raised that only 750 cash are given for the tael. Cash is sometimes called *Caxa*. In Sumatra cash are small pieces of tin or lead, 2500 of which go to a mace.

Cent, or *Centime*, a coin and money of account in France, Holland, Belgium, Switzerland, and in the United States of North America. In France the centime is the fifth part of a sous (about an English halfpenny), and hundredth part of the franc (worth 10*d.* English). In Holland 100 cents = 1 florin. In Switzerland the small coins consist of pieces of 5, 10, and 20 centimes, in base metal, less bulky than the English copper. Centimes are sometimes called *rappen*, which were formerly the tenth part of a batzen. In the money of the United States the cent is the hundredth part of a dollar. Half-cents are coined in the same proportion.

Christian d'Or, a former Danish coin, worth 16*s.* 5¾*d.*

Copang, or *Coban*, a Japanese coin. The old copangs weigh 371 Dutch asen, or 275 English grains, and the gold is said to be 22 carats fine: this would give 2*l.* 4*s.* 7*d.* sterling for the value of the old copang; but it must be observed that the Japanese coins are reckoned at Madras only 87 touch, which is 20⅞ carats, and this reduces the value of the old copang to 2*l.* 1*s.* 10*d.* sterling. The new copangs weigh 180 English grains, and the gold is about 16 carats fine, which gives their value 21*s.* 3*d.* sterling.

Copeck, see *Kopek*.

Cowries, a species of small sea-shells, which, as long as they remain unbroken, are used in parts of Africa, India, &c., as money in small payments: 2560 cowries are generally reckoned for a current rupee. But they have intermediate divisions, thus: 4 cowries make 1 gunda; 20 gundas, 1 punn; 4 punns, 1 ana; 4 anas, 1 cahaun; and 4 cahauns 1 current rupee; but the last proportion is variable. Cowries are also used for money on the Malabar coast, at Siam on the farther peninsula, and in Guinea, where 2000 of these shells are called a macuta.

Crore, a money of account in the East Indies, equal to 100 lacs, or ten millions of rupees.

Crown.—In England, Henry VII. was the first king who coined a crown in gold. He afterwards, as has been already noticed, struck some patterns for a crown in silver; but Edward VI. was the first who coined the silver crown and half-crown for currency. From Elizabeth to Victoria the silver crown and half-crown have been struck in every reign. It is now current for 5*s.*, weighs 18 dwts. 4$\frac{4}{11}$ grs. The half-crown is of half the weight and value. The croone, or crown, was formerly a coin of the Netherlands; those after 1755 were estimated at 2 florins 14 stivers of exchange, or 3 florins 3 stivers current. It was also a coin of Denmark; double, single, and half-crowns were reckoned at 8, 4, and 2 marks crown money, or 8 marks 8 skillings, 4 marks 4 skillings, and 2 marks 2 skillings current.

Crusado, a silver coin in Portugal, of 480 rees, or 2*s.* 2*d.*

Decime, a money of account, and coin in the Revolutionary system, of France: 10 decimes make the franc, or 100 centimes. There were copper pieces of 1 and 2 decimes.

Denier was the 240th part of the livre, or French pound.

Dime, a money of account and silver coin in America, is the 10th part of a dollar. There are also half-dimes.

Doblon, or *Doubloon*, a Spanish gold coin, the ancient value of which has been changed up to 1772, when the former pieces were called in; the doubloon was of the value of 3*l.* 1*s.* 10*d.* The present *doblon* is worth 3*l.* 4*s.* 8*d.* The double and the half of each in proportion.

Doppia, or *Pistole*, an old Italian gold coin, of which the value varies in different states. The Roman doppia was 15¾ lire, or 13*s.* 8½*d.*; that of Parma was 26 lire 14 soldi. The doppia of Genoa was worth about 31*s.* 3*d.*, but few are in circulation, as the Sardinian coinage is now assimilated to that of France.

Doit, or *Duyt*, a small Dutch copper coin, now disused, the 8th part of a stiver, in value half a farthing.

Dollar.—The dollar of the United States of North America, weighing 416 grains of standard silver, is valued at 4*s.* 4*d.* English. It has on the edge, "ONE DOLLAR OR UNIT HUNDRED CENTS," and has its divisions of half and quarter. By an Act of 1837, the silver dollar of the United States is required to contain 412½ grains of standard silver, of which one tenth is alloy, which is now the proportion in all coins of the United States, whether of silver or gold. The Spanish dollar of the old sort, before a new coinage took place in 1772, was of the sterling value of 4*s.* 4½*d.* Till then there were dollars of two denominations, the Mexican and the Sevillan dollar. That which is at present generally circulated as the Spanish dollar is really of the sterling value of 4*s.* 3½*d.* The Greek silver dollar is worth 3*s.* 6½*d.*, and the five-dollar piece is a gold coin of the value of 17*s.* 8½*d.*

Drachma, a silver coin of the kingdom of Greece, worth about 8½*d.*

Ducado, is an imaginary Spanish money, often used in estimating or stating values; it is reckoned at something more than 2*s.*

Ducat, Danish, a gold coin worth 7*s.* 5½*d.*; the specie ducat is worth 9*s.* 4*d.*

Ducat, Dutch, a gold coin, now called in, of the value of 5 guilders 2 stivers. English value, 9*s.* 4½*d.*

Ducat, German, also a gold coin, the rate of coinage of which, although each state has its own ducats, is nearly the same all over Germany, in Hungary and Bohemia; that is, about 9*s.* 4½*d.* or 9*s.* 5*d.* The ducat of Holland is 9*s.* 4*d.* The Austrian double ducat is in proportion. The ducat of Baden, however, of five gulden, coined from 1819 to 1827, is only worth 8*s.* 5¾. The ducat of Saxony is current at 9*s.* 5*d.*

Ducat, the Italian, is a silver coin and money of account at Naples and other places. The Neapolitan ducat is worth 3*s.* 4*d.* The Venetian silver ducats of a former time varied both in weight and fineness. In weight from 13 dwt. 18 gr. to 14 dwt. 19 gr.

Duro, a gold coin of Spain, worth about 4*s.*; with its double, the *dos duro*. The old Spanish silver dollar is also known as the *duro*.

Eagle, an American gold coin, of the value of 10 dollars, or units. Its intrinsic value in English gold was nearly 2*l.* 3*s.* 9*d.* Since 1834 it has been reduced in value. It now contains 258 grs. The value is now 41*s.*

Ecu, a silver coin in the old system of France, and also at Geneva and other places in Switzerland. In France it was of 6 livres; and the *Petit Ecu*, or half-crown, of 3 livres. The ecu, or patagon, of Geneva was worth 3 livres or 10½ florins. Those coined in 1796 were of the English value of 4*s.* 9*d.*

Escalin.—The escalin, or shilling, was formerly a base silver coin in the Netherlands, at 6 stivers of exchange, or 7 stivers current. Of the English value of 6*d.*, and its double in proportion.

Fanam, a small coin in the East Indies, both of gold and silver, now disused. The gold ones were alloyed with silver, and 24 of them were reckoned for an old Negapatam pagoda, which went for 8*s.* The silver fanam of Bombay was worth about 4¾*d.*; that of Pondicherry 3½*d.*

Farthing, an English copper coin, the fourth of a penny. It is said to have been a round coin in the time of some of the later Saxon kings; they usually at that period consisted of the fractions or parts of the penny broken into four. Instances of pennies neatly and accurately cut into halves and quarters occur almost wherever Saxon coins have been discovered. The fourthling, as money, is twice mentioned in the Anglo-Saxon version of the Gospels. (Matt. v. 26; Luke xxi. 2.) Half-farthings were coined in 1852, chiefly for the use of the British colonies.

Faruki, a gold coin of Mysore, struck by Tippoo Saib, of the value sterling of 7*s.* 11*d.* A variety of the pagoda.

Filippo, or *Philip*, an old silver coin of Milan, worth about 4*s.* 8¼*d.*

Florin, a money of account and silver coin in Holland, Belgium, and Germany, called also gulden and gülden, and, by corruption, gilder or guilder. The florin of Holland and Bavaria is worth about 1*s.* 8*d.*; that of Belgium is equal to a franc, or 100 centimes; the heavy (or *conventions münz*) florin of Austria is worth about 2*s.* 4*d.*, but coin is rare throughout the Austrian dominions; paper supplying its place down to notes of 6 kreutzers. At Frankfort-am-Maine it is only worth 1*s.* 7*d.*

Florin is also a gold coin at Hanover and in other parts of Germany, though chiefly current in the countries on the banks of the Rhine; passing generally for 2 rix-dollars current. Assay value about 6*s.* 11*d.*

Florin is also the name of an English silver coin current for 2*s.*, and weighing 7 dwts. 6$\frac{6}{11}$ grs. It was also the name of an earlier English coin, both in gold and silver. [COIN.]

Fourpenny-piece, an English silver coin, the third part of a shilling, weighing 1 dwt. 5$\frac{1}{11}$ grs. There are also silver coins for *threepence*, *twopence*, and *pence*, but the last-named two are not coined for general circulation, and are only given in small numbers as Maunday money.

Franc, a money of account and silver coin of France, Sardinia, Switzerland, and Belgium, with its double, quintuple, and lower proportions, down to 1-5th of the French franc, weighs 77·17 grains, contains 69·453 grains of pure silver, and is worth 10*d.* Those of Belgium, Sardinia, and Switzerland are very nearly the same. The gold coins are pieces of 40, 20, and 10 francs, value 31*s.* 9*d.*, 15*s.* 10½*d.*, and 7*s.* 10¾*d.* The old Switzerland franc was worth 1*s.* 2*d.*

Frederick, or *Friederich's d'Or*, a gold coin in Prussia and Denmark, worth 16*s.* 5½*d.* There are also double and half Fredericks.

Ghuzih, a Turkish silver coin, equal to 25 piasters, or about 4*s.* 6*d.* In Syria, it is a gold coin, but the value is somewhat less.

Gilder, or *Guilder*, see *Florin*.

Giulio, a small coin of base silver, formerly current in Italy; half a lira.

Gold Crown, a coin of Portugal, worth 1*l.* 3*s.* 11*d.*

Grano, a copper coin, and the money of account in Naples, Sicily, and Malta. It is worth 4-10ths of an English penny.

Groschen, a small coin, and money of account in Prussia, Hanover, and other parts of Germany. A Prussian silver groschen is worth a penny English. There are also coins of 10, 5, and 2½ groschen. The *gute groschen* of Hanover are 24 to the thaler, and worth nearly 1½*d.*

Grosso, a silver coin of central Italy, worth about 2½*d.*

Grote, a small coin and money of account, in use at Bremen: 74 grotes make 1 rix-dollar. It is worth rather more than a halfpenny.

Guilder, see *Florin*.

Guinea.—The unit, as it was called, or twenty-shilling gold piece, was first coined by King James I. The appellation of *Guinea* was given because great quantities of them were coined out of gold brought from the Guinea coast by the Royal African Company, which are distinguished by an elephant under the head, some a castle, others without. The guinea had not been long in currency before common consent had raised it to 21*s.* About the æra of the Revolution, James II.'s guinea was paid and received at 21*s.* 6*d.* In the reign immediately subsequent, the gold money remaining without alteration in weight and fineness, and the silver money growing daily of less value by clipping and counterfeiting, occasioned 25*s.*, then 28*s.*, and at last 30*s.* to be given for a guinea; but no sooner was the silver money restored to its first value by the grand recoinage, than the guinea was again reduced, first to 28*s.*, then to 26*s.*, and finally to 22*s.*, and soon after, by common consent, was paid and remained as before at 21*s.* 6*d.*, and continued at that price for twenty years after. In 1717 the guinea was reduced to 21*s.*, at which it continued till the latter part of the reign of George III., when the coining of guineas ceased.

Gulden, a silver coin of Holland, equal to 20 stivers: in Bavaria, 1 gulden = 60 kruzen; they are both worth 1*s.* 8*d.* English.

Heller, is a copper coin, formerly used through most parts of Germany, and worth about a halfpenny English.

Imperial, a Russian gold coin, of 10 rubles; it has its half. The English mint value of the imperial is 34*s.* 4*d.*, and of the half 17*s.* 2*d.*

Joanese, *Johanes*, or *Joe*, a former Portuguese gold coin (called also a *Portuguese*), of the value of 1*l.* 11*s.* 10*d.*

Isabelino, a gold coin of Spain, worth 1*l.* 0*s.* 10*d.*

Khereeh, a gold coin of Egypt and Turkey. That of Egypt is worth about 4*s.* 7*d.*; that of Constantinople, about 4*s.* There are, however, several khereehs, varying in value.

Kopek, or *Copeck*, a money of account and silver and copper coin in Russia. In silver there are pieces of 30 kopeks down to 5: the copper kopek, also in pieces of 10, 5, 3, 2, and 1, is worth about three-fourths of a halfpenny. It is the silver kopek that is the money of account: 100 kopeks = 1 ruble.

Kreuzer, a small copper coin, and money of account in many parts of Germany, worth ¼ of a penny. Sixty kreuzen go to a gulden of Holland or Bavaria.

Lac, a money of account in the East Indies; it is equal to 1 rupees.

Larin, an old coin and money of account in Persia and Arab 2½ mamoodis. It consists of a silver wire, about half an inch in doubled up, and flattened on one side to receive the impress some characters.

Lepton, a copper coin of the kingdom of Greece, the 100th pa a drachma. The piece of 5 lepta, the smallest coin in use, is ne equal to a halfpenny.

Liard, a small French copper coin in the old system of Fran the value of 3 deniers.

Lira, a gold coin of Turkey, circulating chiefly in Syria and Pale of the value of about 18*s.* 6*d.*

Lira, a silver coin of Italy, particularly at Milan and Venice. in fact the Austrian zwanziger. The lira of Lombardy is current about 8½*d.* The *nova lira* of Sardinia was equivalent to the Fr franc. The currency of Lombardy and Tuscany is in a state of tra tion, being assimilated to that of Sardinia.

Lirazza, base silver pieces, formerly current at Venice, of 5, 10, and 5 soldi.

Livornina, an old silver coin of Leghorn, value 4*s.* 5½*d.*

Louis blanc, the name for the old ecus of silver coined in Fr before 1726, at the rate of 9 pieces to the mark of 10 denier grains fine.

Louis d'or, a former gold coin of France, at first worth 20 but reduced in 1786 to 18*s.* 10*d.*; it is now valued at 19*s.*

Lowen Dollar, or *Lyon Dollar*, an old Dutch silver coin at 42 or a little more. It was ⅔ of the ducatoon.

Mace, a small gold coin in Sumatra, weighing 9 grains, and about 14*d.* sterling. In China the mace is the tenth part of a t

Mamoodi, or *Mamoudi*, a money of account and silver Persia. The mamoodi of Gombroon contains ⅝ silver and ⅜ and is worth nearly 3*d.* The mamoodi of Bassora is about 5½*d.*

Maravedi, is now a Spanish money of account, but was form coin. It is now reckoned as the 34th part of a real.

Mark, an old English gold coin, worth 13*s.* 4*d.*

Mark, a silver coin in Denmark, Norway, and Hamburg. Danish mark is equal to 16 skillings, and is worth 4½*d.* The Hamburg is equal to 16 schillings, and is worth about 1*s.* 3*d.*

Max d'Or, or *Maximilian*, an old gold coin of Bavaria, value 1

Mejideh, a Turkish silver coin, circulated in Syria, worth 3*s.* 6*d.*

Milreis, a coin of Portugal = 1000 reis, and worth 4*s.* 6*d.* The of Brazil is reckoned at 3*s.* 7*d.* only.

Moeda, a Brazilian gold coin, worth 1*l.* 15*s.* 7*d.*

Mohur, a coin of gold in the East Indies. The mohur or rupee of the emperor Shah Allum, 1770, was of the value 1*l.* 13*s.* 0¾*d.*; the mohur of the same, 1787, 1*l.* 13*s.* 4½*d.*; the gold mohur of Bengal, of 1789, 1*l.* 13*s.* 7*d.*; the old Bombay m 1*l.* 10*s.* 1*d.*; Surat mohur of the latest coinage, 1*l.* 9*s.* 2½*d.*; T gold rupee, 1*l.* 12*s.* 1¾*d.*; mohur of the Dutch East India Com 1783, 1*l.* 12*s.* 1½*d.*; ditto, 1797, 1*l.* 10*s.* 10½*d.* Some of the halves and quarters in proportion. The present mohur is 1*l.* 9*s.* 3½*d.*

Moidore, a former gold coin of Portugal, of 4800 reis, of the of 1*l.* 1*s.* 8*d.* sterling.

Napoleon, a gold coin of France, the successor of the louis-d the value of 20 francs. The value is 15*s.* 10*d.*; of the half-nap or 10-franc piece, 7*s.* 11*d.*; of the double, or 40-franc piece, 1*l.* 11 The napoleon weighs 99·564 grains, and contains 89·61 grains of gold.

Noble, an old English coin, worth 6*s.* 8*d.*

Oban, the largest gold coin of Japan, three times the value of copang.

Oboli, and *obolicci*, moneys of account in the Ionian Islands; oboli = 1 dollar, worth 4*s.* 4*d.*; 5 obolicci = 1 oboli, which is worth English halfpenny.

Ochavo, the smallest copper coin of Spain; it is reckoned equ 2 maravedis, or the 17th part of a real.

Onza, a Sicilian gold coin of the value of 30 tari, each taro subdivided into 20 grani. Its value is about 10*s.* 3½*d.* There another onza, of a later coinage, of exactly double the weight value.

Onze de oro, a Spanish gold coin; the same as the doblon.

Ora (from the Saxon ore, metal), a money of account among Anglo-Saxons, whatever it might have been in other parts of Eur In the Domesday Survey, it is used for the ounce, or a twelfth par the nummulary pound. There appear to have been two sorts of ora use in the Saxon times, one of sixteen pence to the ora, the other twenty pence. The ora of Domesday Book is perpetually valued twenty pence. The ora of sixteen pence was of earlier date.

Ort, a coin of Norway, called in some parts a mark, and worth about 10¾*d.*

Pagoda, a gold coin on the Coromandel coast, in the East Indi now disused, of which there were several kinds: namely, the pagoda of the value of 7*s.* 5¼*d.*; old Arcot pagoda, 7*s.* 2*d.*; new Arcot pagoda, 5*s.* 8¾*d.*; Onore pagoda, 7*s.* 10*d.*; Mangalore pagoda, 7*s.* 10¾*d.*; pagoda with a crescent and one figure, 7*s.* 6*d.*; pagoda of Pondicherry, 6*s.* 5*d.*; Hyderee hoon, or pagoda, 7*s.* 8*d.*; Sultannee hoon, or pagoda, 8*s.* 5*d.*; Tippoo's farufei, 7*s.* 11¼*d.*

Paolo, a small silver coin at Florence, Rome, and other place in Italy, with its double, half, and quarter. The value of the paolo is 5¼*d.*

Papetto, a small silver coin of Rome, value 10¼*d.*

Pataca, a Brazilian silver coin, worth 4*s.* 2¼*d.* It is often called the Brazilian dollar.

Para, a Turkish and Egyptian money of account. The five para piece is the only copper coin in Egypt. 40 paras = 1 piastre.

Penny.—The early English coins of this name were of silver, and of varying worth. It has been long the largest current copper coin, the twelfth part of a shilling; the fractional halfpenny and farthing are also common; but there has been no copper coin of larger value since the twopenny-piece of George III.

Peseta, a Spanish silver coin, now disused; the old Mexican peseta of two Mexican reals, 1736, was of the value in sterling of 1*s.* 1*d.*; the peseta is now about equal to the French franc, or 9½*d.*

Peso, an imaginary Spanish money frequently used in expressing values, and reckoned at about 2*s.* 8*d.* The peso is used in regulating the exchange with foreign countries.

Peso duro, a money of account at Gibraltar, worth 4*s.* 2*d.*

Pezza, a gold coin of Sicily, now seldom seen, of which the value was 21*s.* 3*d.* It is now a Maltese silver coin, worth 4*s.* 2*d.*

Pfennig, a Hamburg coin, of which 12 = one schilling, and 16 schillings = 1 mark, which in the currency (which varies from banco, the money of account) is worth 1*s.* 2¼*d.*; the mark banco is reckoned at 17¼*d.* In Hanover 24 pfennigen = 1 gute groschen. In Prussia the pfennig is worth one-tenth of an English penny.

Piastra, a silver coin of Naples, now disused, worth 4*s.* English. There was also a mezza-piastra, of half the value.

Piastre, a money of account and a silver coin in Turkey and Egypt. The piastre of Mustapha III., 1757, was of the sterling value of 1*s.* 10¼*d.* The piastre of Egypt, of 40 paras, is now worth only 2¾*d.*, and that of Turkey, 2½*d.*

Pice, a money of account and a copper coin in the East Indies; 14 pice are equal to one ana, a *pice* is therefore worth half a farthing.

Piece of Eight, the old Spanish dollar; also a money of account in what used to be the Danish West India Islands.

Pistole, German, is the common name of coins bearing the name of the state in which they circulate, or the sovereign who coined them. They vary slightly, and an allowance is made for deficiency in weight and fineness; 35¾ pistoles should weigh a Cologne mark of gold, 21⅝ carats fine; they are then called *passir pistoles*, and are worth from 16*s.* 4*d.* to 16*s.* 6*d.*

Plates, the denomination given to certain large copper coins, formerly used in Sweden. Kelly says, "The large copper pieces of the value of 4, 3, 2, 1, ¾, and ½ silver daler, or 12, 9, 6, 3, 2¼, and 1½ copper daler, weighing 7½, 5⅝, 3¾, 2⅝, 1⅞, 1¼, and ⅝ lb. of the victualie or common weight, are no longer considered as a legal coin, but as a sort of merchandise, which every one is at liberty to sell or export after paying the duty on exportation. These in general, but more particularly the 2-daler pieces, are called plates."

Plott, a silver coin formerly used in Sweden, ⅓ of the rix-dollar, of the value of 1*s.* 6*d.* sterling.

Pol, a Russian gold coin; it is the name of the half-imperial, and is worth 17*s.* 2*d.*

Poltin, Poltina, Popoltin, Russian silver coins, of 50 and 25 kopeks, = to the half and quarter ruble. The poltin of the empress Anne was of the value of 1*s.* 9*d.*; that of Elizabeth, 1*s.* 10*d.*; of Catherine II., 1*s.* 7¼*d.*; of Paul, 1*s.* 7½*d.*; of Alexander, 1*s.* 7*d.* The halves in proportion. None of these are now used.

Polturat, a coin of Hungary, not now in use. The currency in all the Austrian possessions is now assimilated.

Quarter, a money of account and coin in Bombay, of which 4 make a rupee.

Quarto, a money of account at Gibraltar; 16 quartos are equal to 1 real, 12 reals are equal to 1 peso duro or dollar. The quarto is therefore rather more than the third of a penny.

Quattrino, a copper coin in Italy, of 2 denarii, now disused. At Rome 5 quattrini made 1 paolo.

Real. There were formerly three small Spanish silver coins called reals, namely, the real of Mexican plate, the real of provincial plate, and the real vellon. The real now is a silver coin, worth about 2½*d.*; there is also a double real. Twenty reals = 1 duro.

Reas, a money of account in Bombay, of which 400 go to a rupee.

Ree, a Portuguese and Brazilian money of account. The five-ree piece, a copper coin, is worth a little more than a farthing. The milris (or piece of 1000 reis) is worth 4*s.* 6*d.*

Rigsbank Daler, a money of account in Denmark, worth 2*s.* 2*d.* The *specie daler* is worth double that sum. 96 skillings = 1 rigsbank daler. In Sweden the rigsbank daler is only worth 1*s.* 8*d.*, but the specie daler is worth 4*s.* 4*d.*

Rixdollar, a silver money of Hamburg and Lubeck, equal to 3 marks. It is also a coin of Bremen, worth 3*s.* 4*d.* It is also used at the Cape of Good Hope, where (in paper) it passes for 1*s.* 6*d.*

Ruble, or *Rouble*, a money of account, and a silver coin in Russia; it is equal to 100 copper kopeks, and is worth 3*s.* 1½*d.* English. There are pieces of ½ and ¼ a ruble also.

Rundstyken, a money of account and coin in Sweden, worth the 12th part of a halfpenny; 12 rundstyken = 1 skilling.

Rupee, a money of account and silver coin in the East Indies. The coins, which were formerly struck at the Calcutta mint, were sicca rupees, also called silver rupees, and gold mohurs, sometimes called gold rupees; 16 of the former, by regulation, were to pass for one of the latter. The silver rupee has its half. The present rupee, called the Company's rupee, contains 16 anas, and is reckoned at 2*s.* sterling.

Schilling, a coin of Hamburg, of which 16 = 1 mark; it is therefore the 16th part of 1*s.* 2¼*d.* In Mecklenburg Schwerin it is the 24th part of a neue thaler, which is worth 2*s.* 3*d.*

Schwaren, a coin of Bremen; 5 schwaren = 1 grote; 72 grotes = 1 rix-dollar; the schwaren is therefore worth the 9th part of a penny.

Scudo, a money of account, and a silver coin in many parts of Italy, at Sicily, and Malta. The scudo of Rome is worth 4*s.* 2½*d.*; that of Tuscany about 4*s.* 5*d.*; that of Sicily and Malta about 4*s.* 1*d.* The ten-scudo piece is a gold coin.

Sequin, or *Zecchin, Italian*, called also *Gigliato*, a former gold coin of Venice, Genoa, Rome, Milan, Piedmont, and Tuscany, of the average value of 9*s.* 4½*d.* It is also used in Algeria, where it is worth 6*s.* 10¾*d.*

Sequin, or *Checqueen, Turkish;* the gold coins of Turkey are the sequin funducli, with halves and quarters; the double sequin, or yermeebeshlik, and the roubieh. There are other sequins beside the above, which bear different names, and their values also vary according to the periods of their coinage. The sequin of Egypt is valued at 5*s.* 4½*d.*

Shilling, an English silver coin, the twentieth part of a pound, and weighing 3 dwts. 15$\frac{3}{11}$ grs. It represents the old Saxon scilling; it was also called a testoon, from the head on it when coined by Henry VII.

Shoe of gold, an ingot, used as money in China. The name is English. Kelly, speaking of China, says, "Gold is not considered as money, but as merchandise; it is sold in regular ingots of a determined weight, which the English call *shoes* of gold; the largest of these weigh 10 taels each, and the gold is reckoned 94 touch, though it may be only 92 or 93."

Sixpence, an English silver coin, the half of a shilling, weighing 1 dwt. 19$\frac{7}{11}$ grs.

Skilling, a copper coin of Denmark, worth about a farthing. The Norway skilling is worth nearly a halfpenny.

Soldo, a small copper coin of Italy. There are half soldi, and quattrini, the fifth part of a soldo.

Sou, or *Sol*, a money of account and copper coin in France and Switzerland. It is equal to 5 centimes, and is worth about a halfpenny.

Souverain, a former gold coin of Austria. Its value was 13*s.* 11¼*d.* There were also half and double souverains.

Sovereign, the name of an English gold coin in use as early as 1526; but name and coin were discontinued till revived in the latter end of the reign of George III. and applied to the coin now forming the unit of our gold currency. The sovereign weighs 5 dwts. 3¼ grs., and is worth 20*s.* of the Mint standard gold of 22 carats fine. The *half-sovereign* and *double-sovereign* have precisely proportionate values.

Stiver, a money of account and copper coin in Holland and the Netherlands, containing 2 greets Flemish, or 8 duyts, or doits, and valued at one penny English. It is also used as a money of account in Denmark: 96 stivers = 1 rigsbank daler.

Tael, a money of account in China, reckoned at 6*s.* 7*d.*

Taro, a silver coin of Sicily and Malta, of the value of 4*d.*

Testone, or *Testoon*, a silver coin in Italy, and also in Portugal. In Italy the testone of Bologna is rated at 30 soldi; at Parma the testone is of 6 lire 6 soldi; at Rome of 6 paoli. Kelly gives the sterling value at a little more than 1*s.* 3*d.* The value of the Portugal testoon is 5¼*d.*

Thaler, is the German dollar, of which almost every state has its own. The specie dollar varies but little in value, which is about 4*s.* 0¾*d.* The current thaler and the reichsthaler are moneys of account, worth about one-third less. The *Prussian, Hanoverian*, and *Brunswick* thaler is worth 2*s.* 11*d.*; the *Convention* thaler about 3*s.* 11*d.*; the *Kron* thaler about 4*s.* 6*d.*: all circulate in the north of Germany.

Tornese, a copper coin of Naples, of the value of half a grano, or $\frac{3}{10}$ths of an English penny.

Vintem, a Portuguese and Brasilian copper coin, worth 20 rees; there are also 3, 6, and 12 vintem coins in silver.

Zwanziger, or *Kopfstück*, of Würtemberg, is a silver coin worth 8*d.* English; the name is properly Austrian, where it passes for 20 kreutzers, while in Würtemberg and Bavaria it passes for 24.

There are, no doubt, numerous others both as coins and as moneys of account, but the most of them will be found local, and comparatively unimportant. The progress in every civilised country has been to simplify its currency; and in various instances to assimilate it to that of a neighbouring country, or of one with which they have much commercial intercourse. For further information see *The Modern Cambist* by W. Tate. In most of the continental countries of Europe, except France, Holland, and Belgium, the greater part of the currency consists of paper.

MONK. [MONACHISM.]

MONOCEROS (the Unicorn), a constellation of Hevelius, surrounded by Hydra, Canis Major, Orion, and Canis Minor. It does not contain any stars of conspicuous brightness.

MONOCHORD (*μόνος, one*, and *χορδή, a string*), an instrument of one string, used for the purpose of ascertaining and demonstrating the relative proportions of musical sounds. It is composed of a board, or rule, divided and subdivided into various parts, and of a string distended between two bridges, one of which is placed at each end of the rule. There should also be a moveable bridge applicable to the graduated line, in order to stop the string at the distances required, leaving both hands of the operator at liberty; but this is not indispensable. The invention of the Monochord is attributed to Pythagoras, and Ptolemy measured and proved all his intervals by it. Guido also, in his 'Micrologus,' strongly recommends the use of this instrument, and gives ample directions for its division, according to his system, for a translation of which we refer the reader to Hawkins's 'History,' i. 449. In Dr. Crotch's 'Elements of Musical Composition,' will be found a simple and cheap method of constructing a Monochord, with plain rules for dividing it for common practical purposes.

MONOGRAM, a cipher or character formed by an interlacing of letters, intended as an abbreviation of a name. Monograms are of very ancient date. They are not uncommon upon Greek coins, especially those of Macedonia and Sicily. They likewise occur upon the coins of the Seleucidæ, and are found upon many of the family coins of Rome, though not upon those of the Roman emperors till a late period.

The monogram of Jesus Christ ☧ upon the coins of Constantine the Great, is well known. It was continued frequently by his successors, even as low down as Alexander Comnenus and Theodorus Lascaris, and was also placed at one period upon the Roman labarum.

Montfaucon, in his 'Palæographia Græca,' p. 144, has given a small plate of monograms used on coins, and, in ancient manuscripts, to represent the names of Greek cities. Such will also be found in Schläger, 'Comment. de Numo Alex. M.,' tab. 3; and in Frölich, 'Annal. Reg. Syr.,' tab. 20. Dr. Charles Combe, in the 'Museum Hunterianum,' 4to, Lond., 1782, plates 63 and 64, has given no less than four hundred and twenty monograms which occur upon the coins of Greek states and cities: others will be found in tabb. xiv., xv. of the 'Veterum Populorum et Regum Numi qui in Museo Britannico asservantur,' 4to., London, 1814: and see the works on numismatics generally.

The conjunction of two, three, or four letters together is not uncommon in Greek and Roman inscriptions. Many of those of the Roman time will be found in Gerrard's 'Sigillarium Romanum,' 4to., Lond., 1792. Père Menestrier has preserved those of many of the popes. Ducange, in his 'Glossary,' has given tables of those of the popes, emperors, and the kings of France. Monograms appear upon almost all the coins of the kings of France of the second race, that is, from A.D. 751 to 987. (Le Blanc, 'Traité Historique des Monnoyes de France,' pp. 87-144.) Eginhard gives as a reason for Charlemagne's using a monogram upon his coins, that he could not write; and Le Blanc adds that a great many bishops did the same for the same reason, which is absurd, as at that period it was the fashion of Europe generally. They appear upon our own Saxon coins, and especially upon those of Alfred.

Monograms were almost universally used by the early engravers. Bartsch, in his 'Peintre Graveur,' has given tables of the monograms used by those of Germany and Italy. The French artists more rarely used monograms. Passavant, in his 'Peinture Graveur,' gives the monograms omitted by Bartsch. Bryant, in his 'Dictionary of Painters and Engravers,' has several plates of monograms; and indeed, most recent writers on engraving have supplied their readers with the monograms of the engravers whose works they notice. The most extensive information however on this class of monograms will be found in the best edition of Brulliot's 'Dictionnaire des Monogrammes, Marques figurées, Lettres initiales, Noms abrégés, &c. avec lesquels les Peintres, Dessinateurs, Graveurs, et Sculpteurs ont désigné leurs Noms,' 2 tom. 4to., Munich, 1832. M. Alphonse Wyatt has in a series of papers (with fac-similes) in vols. i. and ii. of the 'Gazette des Beaux-Arts' (Par., 1859), opened up a previously untouched branch of the subject—the monograms affixed by celebrated amateurs to drawings and engravings which have formed part of their collections, and in the course of his investigations he has collected a great deal of curious information.

MONOMANIA. [INSANITY.]

MONOPOLY, from the Greek *monopōlia* (*μονοπωλία*), which occurs in Aristotle's 'Politick' (i. 11), where it is used simply in the sense of a man buying up the whole of a commodity so as to be the sole holder of it, and to have the power of selling it at his own price. When the word *monopolium* was used by Tiberius in addressing the Roman senate (Suet., 'Tib.,' c. 71), he thought an apology necessary for introducing a new word. The word however soon came into common use. The term monopoly, which literally signifies *single* or *sole selling*, is used in a constitution of Zeno ('Cod.,' iv. 59) in the sense in which it is used by Aristotle, and in the sense of what our law understands by forestalling, engrossing, regrating, to which we may add combining to keep up prices. Zeno declares that no person shall exercise a monopoly of clothing, fish, or any other thing adapted for food or use. He gives no definition of monopoly. The term, however, must be explained from the context, from which it appears to signify any means by which a person gets or attempts to get the whole of any commodity into his possession for the purpose of enhancing the price. In the same constitution he forbids all combination among dealers to raise the prices of any commodity. Zeno's punishment for monopoly was confiscation of the goods of the offender and perpetual exile.

A monopoly, according to the English law, is defined by Coke (3 'Inst.,' 181, c. 85, "against monopolists," &c.) to be "an institution or allowance by the king, by his grant, commission, or otherwise, to any person or persons, bodies politic or corporate, of or for the sole buying, selling, making, working, or using of any thing, whereby any person or persons, bodies politic or corporate, are sought to be restrained of any freedom or liberty that they had before, or hindered in their lawful trade." In 'Le Case de Monopolies' (11 Co., 86, *b*) it is said that every monopoly has three inseparable incidents—the raising of the price, the deterioration of the commodity, and the impoverishment of artificers and others. It appears that these inseparable incidents were considered as tests by which a grant savouring of monopoly might be tried.

Every royal grant or letters patent tending to a monopoly, as thus defined and explained, was void. The crown, however, could by letters patent grant and create exclusive privileges of buying and selling when such grant was of general use, or when the grant was to an individual who had introduced into the country something new and useful. This prerogative of the crown was often abused, and by none more than by Elizabeth, who granted many patents of monopolies for the purpose of raising money. As an instance of this, Elizabeth had granted to a certain person the sole making, importing, and selling of playing cards, which grant was declared void by the judges. ('Le Case de Monopolies.')

It seems, then, that the word monopoly was never used in English law, except when there was a royal grant authorising some one or more persons only to deal in or sell a certain commodity or article.

By the Act of 21 Jac. I., c. 3, all monopolies and all commissions, grants, licences, charters, and letters patent to any person or body politic or corporate, of or for the sole buying, selling, making, working, or using of any thing, or of any other monopolies, &c., are declared contrary to the laws of the realm and utterly void and of none effect.

By the sixth section of the same statute, the above provisions do not extend to letters patent and grants of privilege thereafter to be granted for fourteen years or under, of the sole working or making of any new manufacture to the true and first inventor thereof, which others at the time of making such letters patents and grants shall not use, so as also such letters patent be not contrary to the law or mischievous to the state, or generally inconvenient. This section is the foundation of the present law as to patents for inventions. [PATENTS.]

Copyright and patents are now generally placed among monopolies by legal writers, but not correctly. The original legal sense of the term monopoly has been already explained; and the power of the crown to grant patents is now limited and defined, as well as the several formalities to be observed in obtaining them. Any patent not obtained in due form is void; and the term monopoly, as above explained, has legally ceased to exist.

There is still a vulgar and common use of the term monopoly, which is incorrect, inasmuch as it has not the sense which monopoly had.

If a number of individuals were to unite for the purpose of producing any particular article of commodity, and if they should succeed in selling such article very extensively, and almost solely, such individuals in popular language would be said to have a monopoly. Now, as these individuals have no advantages given them by the law over other persons, it is clear they can only sell more of their commodity than other persons by producing the commodity cheaper and better. Such so-called monopoly, then, is neither the old legal monopoly, nor does it rest on any legal privilege. There would, however, be no objection to calling it a monopoly in the ancient sense of that term, if the word were not now used in a bad or unfavourable sense, which probably dates from the time when real monopolies were granted by the crown, and were very injurious to the nation. Between a monopoly as it once existed, and a monopoly as it is now vulgarly understood, there is this difference: the former was only derived from a grant of the crown, and was often injurious to all persons except the patentee; that which is now vulgarly called a monopoly is nothing more than the power which an individual or a set of individuals acquire, by means of capital and skill, of offering something to everybody cheaper and better than they had it before, and it is therefore an advantage both to the so-called monopolists and to everybody else.

The case of a number of persons combining to produce and sell, or to buy and sell, a thing, has been taken, as being one which is the most striking and oppressive kind of monopoly, in the vulgar sense of that term. An individual, however, may, in this sense, become a monopolist: as if a man should buy up all the tallow in Russia, and so make candles as dear as he pleased; or (to take a case which would appear a still greater act of monopoly, as being more sensibly felt), as if a man should buy all the corn in a country, and so make bread as dear as he pleased. Without discussing the question as to the advantages and disadvantages to a nation of this kind of monopoly, it is enough to put it upon those who disapprove of such wholesale buying, to say how far, and to what amount, they will allow a man to use his capital and exercise his commercial skill; for it is incumbent on those who would deprive a man of such liberty to say exactly how far such liberty should go.* Further, if such persons wish to be exact in their language, they should use another word than monopoly, which had once a particular meaning, as above explained, and signified a different thing from that which they call a monopoly. And if they will apply this word monopoly to a person or persons who, by industry and skill, and the judicious employment of capital, make and sell, or buy and sell, much more of a thing than anybody else, they should consider whether—inasmuch as buying and selling are free to all, and as all people wish to buy as cheap as they can, and as good as they can—they will apply this word in an invidious sense to any person or persons who can only command customers because the customers like to go to them, or because the customers can get the thing nowhere else, owing to no other persons having provided themselves with the commodity for sale.

That kind of monopoly, or sole-selling, or dealing, which is given by the law of copyright, and by patents, is in effect a kind of property created by law for the benefit of an author or inventor, and which he could not effectually acquire or secure without the aid of the law. Is is not, however, a monopoly in any sense in which that term has ever been used. Whether it is profitable or injurious to the community it a question that concerns legislation.

MONOSTEARIN. [Stearic Acid.]

MONOSYLLABLE. [Syllable.]

MONSOON (in French *mousson*), is a term applied to the periodical winds of the Indian Ocean, and, according to Marsden, is a corruption of the word *mossem*, which, both in Arabic and Malay, signifies a year. These winds have from the earliest times attracted the attention of the navigator, as, by taking advantage of their regular blowing, an easy and speedy voyage may be calculated upon with certainty; whilst, by contravening their force, the voyage is rendered laborious, slow, and uncertain.

The Indian Ocean is open towards the south, and no considerable island occurs between the meridian of Madagascar and that of the western shores of Australia, as far south as the sea has been navigated (70° S.); on the west is Africa, on the north Arabia, Beloochistan, and Hindustan, and on the east India without the Ganges, the Indian Archipelago, and Australia. The monsoons, however, prevail also in the seas between Australia and China; and these seas are considered as a portion of the Indian Ocean.

The southern part of the Indian Ocean, or that which lies between the western coast of Australia and the island of Madagascar, has the regular south-east trade-wind, which extends southward to between 28° and 30° S. lat., but its northern border varies between 12° and 3° S. lat., approaching nearer to the equator when the sun is in the northern hemisphere. Cook found it, in February, between 10° and 12°; Basil Hall, in June, near 7°; Nicholson, in August, at 3½°; and Carteret, in October, at some distance south of Java.

The monsoons do not begin immediately north of the northern border of the trade-wind, but are separated from it by a region which corresponds with the region of calms in the Atlantic. [Calms.] Though calms occur in this region of the Indian Ocean also, they are not regular, and are frequently interrupted by winds, which, when the sun is in the northern hemisphere, generally blow between south-west and north-west, and, in the other six months, between south-east and north-east. They are usually called the north-west and north-east monsoons, but not with propriety, as they do not coincide with the proper monsoons in time, nor do they seem to be connected with them in any way.

The region of the proper monsoons lies to the north of this region, and they blow with the greatest force and with most regularity between the eastern coast of Africa and Hindustan. When the sun is in the southern hemisphere a north-east wind, and when it is in the northern hemisphere a south-west wind blows over this sea. When the sun passes the equator the winds are variable, and accompanied with gales, hurricanes, thunder-storms, and calms; but it is observed, that as soon as one of the monsoons ceases, the clouds in the upper regions of the atmosphere take the direction of the opposite monsoon, though it is not till three or four weeks afterwards that this monsoon becomes prevalent on the surface of the sea.

The north-east monsoon blows from November to March. It extends one or two degrees south of the equator. It becomes regular near the coasts of Africa sooner than in the middle of the sea, and near the equator sooner than in the vicinity of the coasts of Arabia. It blows with most regularity and force in the month of January, and especially in the most northern angle of the sea, between the island of Socotra and Bombay. This monsoon is not accompanied with rain on the eastern coast of the sea, but it brings rain to the eastern coast of Africa, where the rainy season falls between the beginning of November and the end of March. It may be laid down as a certain fact that neither of the monsoons brings rain by itself, but only when it reaches a coast after having passed over a wide extent of sea.

The south-west monsoon does not extend south of the equator, but usually begins a short distance north of it. It blows from the latter end of April to the middle of October. Along the coast of Africa, where it rather proceeds from the south, it appears at the end of March; but along the coast of Malabar, not before the middle of April: it ceases, however, sooner in the former than in the latter region. It is also observed that the south-west monsoon sets in sooner on the coast of Malabar than on that of Canara and Concan. At Anjengo (in 8° 30′ N. lat.) it makes its appearance on the 12th of April, and at Bombay on the 15th of April, so that it proceeds a degree farther northward in the course of three days. It reaches the coast of Arabia still later. On the sea it is a serene wind of moderate force; but when it approaches the coast of Hindustan, the atmosphere becomes overcharged with moisture, and the rain descends in torrents, but more abundantly on the southern than on the northern coast. Near Tellicherry, the annual quantity of rain amounts to 116 inches, but at Bombay it does not exceed 63 inches. It was formerly supposed that the south-west monsoon was arrested by the Western Ghauts, but a better acquaintance with the table-land of Deccan has shown that the greatest quantity of rain descends on it during the south-west monsoon, and with a wind blowing from south-west. It has latterly been observed that its effects extend to the coast of Coromandel, where, during its prevalence, a few showers fall. But the farther this monsoon advances into the continent, the smaller is the quantity of rain which it causes. Northward its effects extend over the table-land of Malwa, the low country along the course of the Indus, and even to the coast of Beloochistan, as far as the Straits of Ormuz.

Both monsoons occur in the Bay of Bengal, but there they are somewhat modified and less regular. The north-east monsoon does not set in regularly before the beginning of December, when it blows from north-north-east and east-north-east. In January and February it is irregular, and frequently turns to the south-east; and in March it ceases entirely in the centre of the sea, and blows faintly in the north-eastern parts, with long intervals of calms. Though the north-east monsoon only becomes regular in December, it is preceded by heavy squalls and winds in the southern parts, especially along the coast of Coromandel; and it is during these squalls that this part of Hindustan is fertilised by abundant rains, which however are less plentiful than those brought to the coast of Malabar by the south-west monsoon. The mean annual quantity of rain at Madras does not exceed 46 inches. The south-west monsoon is more regular in its strength, but not in its direction, as it blows frequently from the south, and even from south-east, especially near the mouth of the Ganges. Little rain falls during this wind on the west coast of the Gulf of Bengal; but rain is abundant in the countries which enclose it on the north, in which direction it extends to the foot and declivities of the Himalaya mountains, and as far as the place where the Ganges issues from the range; but here too the quantity decreases as it advances inland. The mean annual quantity of rain at Calcutta is nearly 72 inches, and at Benares 46¼ inches. The quantity of rain which, during this monsoon, descends on the eastern coast of the bay, is still larger, especially towards its northern recess, in Chittagong and Aracan, where, according to a rough estimate, founded on partial observations, it amounts annually to 200 inches.

The monsoons are subject to much greater variation to the east of the Bay of Bengal. In the Chinese Sea and the Sooloo Sea the wind is south-south-east when the sun is in the northern hemisphere, but it does not blow with regular force, being sometimes interrupted by high winds. It brings rain to all the countries which surround the sea on the north and east. In the southern provinces of China, in the Philippine Islands, and in the Sooloo Islands, the rainy season commences in the beginning of May, and terminates in September and October. The rains, though rather abundant, when compared with those which fall in the countries without the tropics, are much inferior in quantity to the rains in Bengal and Chittagong. It is remarkable that these rains extend to the countries surrounding the Gulf of Tonkin. The monsoon blows in these seas from north-north-west when the sun is in the southern hemisphere; but it is still less regular in its force, though more so than in the Bay of Bengal. It brings rain to the countries on the west and south of the sea, and especially to the coast of Cochin China Proper and the northern shores of Borneo, where the rains commence at the end of October and continue until March. They are more abundant than those which fall during the opposite monsoon on the northern and eastern shores of the Chinese Sea.

Along the equator, and about one or two degrees from it, it appears that the winds are subject to frequent changes; and it is also observed that the islands situated within these limits have frequent showers nearly every day in the year.

In the Java Sea and the southern parts of the straits which lead from that sea to the Chinese Sea, the wind generally blows from the west when the sun is in the southern hemisphere, and from the east when it is in the northern hemisphere; but it turns frequently to the north-west and south-east, which is also the case with the winds in the sea south of Java, and between the Lesser Sunda Islands and Australia. The westerly winds bring rain to these islands, but not in such abundance, as the south-west monsoon carries them to Malabar. During the easterly winds the air is generally dry, but sometimes there are heavy showers. In these islands neither season has that decided permanent character which distinguishes it on the continent of India, and the rains are far from being so violent. But the northern coast of Australia partakes more of the character of the season of the continent of India. The rains indeed do not seem to come down with such violence; not a drop falls during June, July, August, and September which is also sometimes the case in Java and the Lesser Sunda Islands.

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* At Athens there was a law which limited the amount of corn that a man could buy. (Lysias, *κατά τῶν σιτοπωλῶν*.)

The direction of the monsoons in the vicinity of the land is frequently changed by the direction of the coast, especially when a mountain range extends along the shores. The most remarkable instance of this phenomenon is observed on the south-western coast of the island of Sumatra. The south-west monsoon is felt at Acheen Head, its most northern point; but, being opposed by the range of high mountains running along the south-western coast, it is changed into a north-west wind, which blows as far south as 1° N. lat. South of the equator the wind is not south-west, but south-east, and may be considered as the trade-wind, which, as already observed, extends as far north as 3° S. lat. when the sun is in the northern hemisphere. During this period that part of the island which lies north of the equator has its rainy season, whilst the southern districts have dry weather. When the sun is in the northern hemisphere the southern portion has abundant rains, with frequent thunder-storms; and the northern enjoys a serene sky. In that season of the year the wind blows in the southern part from north west, and is that wind which is generally called the north-west monsoon; but the northern districts are under the influence of the north-east monsoon.

It is not easy to explain the origin of these periodical winds. It is admitted on all hands that they are only a modification of the trade-winds, produced by the peculiar form of the countries lying within and around the Indian Ocean. This modification, it is said, is produced by the difference of temperature to which the high table-lands of Asia and Africa are subject during the two great divisions of the year. When the sun is in the northern hemisphere the heat causes such a rarefaction of the atmosphere on the table-land of Asia as to make the air flow rapidly from the colder region near the equator to that quarter; and this is the south-west monsoon. When, on the contrary, the sun, during its stay in the southern hemisphere, heats the air on the table-land of southern Africa, the contrary effect takes place, and that is the north-east monsoon. This explanation however is hardly satisfactory. It is a fact that on the high table-lands the air is always in a state of rarefaction, compared with that of low countries, and that the summer-heat is never such as to cause a degree of rarefaction sufficient to produce a motion in the air from the lower countries towards the table-lands. Besides this, the Himalaya mountains, with their immensely high masses, lie in the line in which the south-west monsoon blows, and its effects are not observed to be sensible in the higher part of that range. The table-lands of Beloochistan and Arabia cannot be considered as affecting the direction of the wind, for in that case the wind would rather blow from the south-east than from the south-west. We think therefore that the cause of this modification of the trade-wind must be sought for in less remote localities. As for the north-east monsoon, we are inclined to consider it entirely as a continuation of the north-east trade-wind, which is only interrupted by the two peninsulas stretching southward into the Indian Ocean; and this interruption is the cause why it is commonly less constant and regular than the trade-wind itself. The question therefore is only why this trade-wind is interrupted by a wind blowing in an opposite direction when the sun is in the northern hemisphere. In this part of the year the trade-wind in the northern hemisphere retires thirteen degrees from the equator. If this fact is applied to the Indian Ocean, only the most northern recesses of the three gulfs, the Arabian Sea, the Bay of Bengal, and the Chinese Sea, would fall within its limits, and the remainder would be within the region of calms. In such a state of indifference a less powerful agency may produce a great effect. The south-east trade-wind, which, when the sun is on the north of the equator, extends to the vicinity of the equator, is prevented by the elevated table-land of Africa from proceeding in its direction, and is therefore diverted from its course. It follows the winding of the coast to the north-east; but as the coast of Africa, as well as that of Arabia, is skirted by very high mountains, it finds no way to escape in a western direction. It would however probably not acquire that degree of constancy and force by which it is characterised, if it did not blow towards a country in which a considerable rarefaction of the air is produced by the sun's approaching to the northern tropic. This is the Indian Desert, called Thurr, in which the heat in summer rises to an excessive degree, on account of its small elevation above the sea, its sandy soil, and the almost complete want of vegetation. The rarefaction produced by this heat gives strength and constancy to the south-west monsoon, and carries it to the very base of the Himalaya mountains, though the desert itself does not partake of the fertilising rains which this monsoon brings to all the coast whose mountains oppose its progress. This, we think, is sufficient to explain the south-west monsoon in the Arabian Sea, where it is most constant and regular.

The south-east trade-wind, not extending to the north of the equator, cannot be considered as contributing to produce the south-west monsoon in the Bay of Bengal; and this wind therefore seems to owe its existence merely to the rarefaction of the air produced by the summer-heat in the wide plain of the Ganges; but as this plain is partly covered with trees (Sunderbund and Terai) and nearly everywhere with vegetation, the effect of the heat on the temperature of the air is less regular; and thus it may be explained that the south-west monsoon in this sea is less regular and constant. The vegetation which covers the Gangetic Plain is probably also the reason why the rains brought by the monsoon are distributed over its whole extent, whilst it passes over the dry sands of the Thurr almost without letting a single shower fall.

The origin of the south monsoon in the Chinese Sea is more difficult to explain. The great plain of Siam and Camboja, the mountain-range of Cochin China, which extends along the shores of the sea from south to north, and the plains of Tonquin, probably contribute largely to it; but we are too imperfectly acquainted with the extent and nature of these plains to be able to form a correct opinion on this point. That this south monsoon extends to the island of Formosa can hardly be adduced as an objection to this explanation, when it is considered that the north-east trade-wind retires to the most northern corner of the Chinese Sea, and is there very feeble and irregular.

As for the monsoons of the Java Sea and of the seas between the Lesser Sunda Islands and Australia, they seem to owe their origin principally to the changes of temperature which occur in the countries lying along the northern coast of Australia. [WIND.]

MONSTRANS DE DROIT. [PETITION OF RIGHT.]

MONT DE PIÉTÉ (MONTE DI PIETÀ, in Italian), is the title of certain pawnbroking establishments which originated in Italy in the 15th century, the object of which was to lend money to necessitous people at a moderate interest. The Jews, who were the great money-lenders in that age, exacted an enormous interest, as much as 20 to 25 per cent. The Papal government and other Italian governments established a kind of bank, which lent money upon pledges, for a fixed term, at a low rate of interest, intended chiefly to defray the unavoidable expenses of the establishment; at the expiration of which term, if the capital lent and interest were not repaid, the pledges were sold, and the surplus money, after paying the debt incurred, was restored to the owners. In most instances however the term might be renewed by merely paying the interest. The administration of the Monte di Pietà was to be conducted upon economical and strictly equitable principles, and it was under the inspection of the government as a public benevolent institution. This at least was the original principle, although occasionally deviated from in consequence of the cupidity or necessities of the governments themselves.

This institution was introduced into other countries, especially into Flanders. In Spain there were also similar establishments at Madrid and some other large towns, but in no country were they so generally spread as in Italy.

When the French under Bonaparte invaded Italy in 1796-7, they plundered the Monti di Pietà of Milan, Modena, Parma, and most other towns. At Rome, Pope Pius VI., being pressed by the French to pay an enormous sum for war contributions, was obliged to seize upon the richer pledges in the Monte di Pietà, for the repayment of which he gave bonds; but these bonds lost all value in the subsequent invasion of Rome by the French in 1798. The Monti di Pietà have been re-established in some of the Italian cities, and there is an institution of a similar character in Paris.

MONTANISTS. [MONTANUS, in BIOG. DIV.]

MONTEM CUSTOM, the ancient custom of a procession of the scholars of Eton School in Buckinghamshire *ad montem*, which has been discontinued since 1844. It used to be made every third year, on Whit-Tuesday, to a tumulus near the Bath Road, which has acquired the name of Salt Hill, by which also the neighbouring inns have been long known. The chief object of the celebration was to collect money for *salt*, as the phrase is, from all persons present, and it was exacted even from passengers travelling the road. The scholars who collected the money were called salt-bearers, and they, as well as others of the scholars, especially the captain, who was the senior scholar, the ensign, whose duty it was to flourish a flag on the mount, and the scouts, who collected the salt, were dressed in fanciful rich habits, generally military. Tickets inscribed with some motto, such as *Ad Montem*, *Mos pro Lege*, or *Pro More et Monte*, by way of pass-word, were given to such persons as had already paid for *salt*, as a security from any further demands.

This ceremony has been frequently honoured with the presence of the sovereign and the royal family, whose liberal contributions added to those of many of the nobility and others who had been educated at Eton, so far augmented the general collection that it has been known to amount to near 1000*l*. The sum so collected was given to the captain of the school, or senior scholar, who was going off to Cambridge, for his support at the university. It would be in vain, perhaps, to trace the origin of all the circumstances of this singular custom, particularly that of collecting money for *salt*, which had been in use from time immemorial. The procession itself seems to have been coeval with the foundation of the college, and it has been conjectured, with much probability, that it was that of the *Bairn*, or *Boy-bishop*. It originally took place on the 6th of December, the festival of St. Nicholas, the patron of children, being the day on which it was customary at Salisbury, and in other places where the ceremony was observed, to elect the Boy-bishop from among the children belonging to the cathedral. It is only since 1759 that the time of the celebration of the Eton Montem was changed, and in 1778 it appears to have been held biennially. It was formerly a part of the ceremony that a boy dressed in a clerical habit, with a wig, should read prayers.

MONTH. [MOON; YEAR.]

MOOD, or MODE. [VERB.]

MOON (Latin *Luna*, Greek σελήνη, sĕlēnē), the satellite of the earth, a heavenly body which moves round the earth, sharing the motion of the earth round the sun.

In a day or two (depending on the state of the weather) from the time called in the almanacs "the new moon," a thin silver crescent is seen with its horns turned from the sun and placed to the eastward of the sun, after which it soon sets. Its distance from the sun increases, the horns at the same time growing fuller, until, in 7¼ days, it is at ninety degrees (or as far as from the horizon to the zenith) distant from the sun, and the crescent has become a semicircle of white light. The distance still increases, until the moon is 180° distant from the sun, or in the opposite part of the heavens, by which time the light part has become a full circle: this happens in somewhat more than 14½ days from the new moon. The satellite still continues its revolution among the stars, becoming westward of the sun after the full moon, and, decreasing by the same steps as it increased, is lost a day or two before the time which the almanacs point out as the next new moon. The whole of this process takes up what is called a *lunation*, or a *lunar month*: the lunar months are slightly unequal, but their average period is 29 days, 12 hours, 44 minutes, $2\frac{9}{10}$ seconds, or 29·5305887215 mean solar days. To show the irregularity of the lunations, we give the times of all the new moons which take place in the years 1860 and 1861, with the intervals.

NEW MOONS. 1860, 1861.

			h	m		Excess of Interval over 29 days. h	m
1860.	Jan.	23	0	16	A.M.	19	23
,,	Feb.	21	7	39	P.M.	18	21
,,	March	22	1	56	P.M.	15	49
,,	April	21	5	45	A.M.	13	1
,,	May	20	6	46	P.M.	10	37
,,	June	19	5	23	A.M.	8	56
,,	July	18	2	19	P.M.	8	0
,,	Aug.	16	10	19	P.M.	7	50
,,	Sept.	15	6	8	A.M.	8	27
,,	Oct.	14	2	36	P.M.	9	59
,,	Nov.	13	0	35	A.M.	12	12
,,	Dec.	12	0	47	P.M.	14	50
1861.	Jan.	11	3	27	A.M.	16	38
,,	Feb.	9	8	5	P.M.	17	32
,,	March	11	1	37	P.M.	17	19
,,	April	10	6	56	A.M.	16	11
,,	May	9	11	7	P.M.	14	31
,,	June	8	1	38	P.M.	12	34
,,	July	8	2	12	A.M.	10	41
,,	Aug.	6	0	53	P.M.	9	18
,,	Sept.	4	10	11	P.M.	8	45
,,	Oct.	4	6	56	A.M.	9	7
,,	Nov.	2	4	3	P.M.	10	13
,,	Dec.	2	2	16	A.M.		

It appears then not only that the lunar month varies, but that there is no yearly cycle of variation. Before however we make any remark on the preceding, we shall place by its side materials for confidence in the almanac from whence the preceding times were quoted. Taking at hazard a volume of astronomical observations, and opening the part where the results of the lunar observations are found, we took the first right ascensions [ASCENSIONS] of the moon which we came to, opposite to which, for comparison, were written the predicted right ascensions of the moon for the same times. The dates matter nothing, since it is only the accordance of prediction with observation which is to be noticed. ('Camb. Obs.,' 1835.)

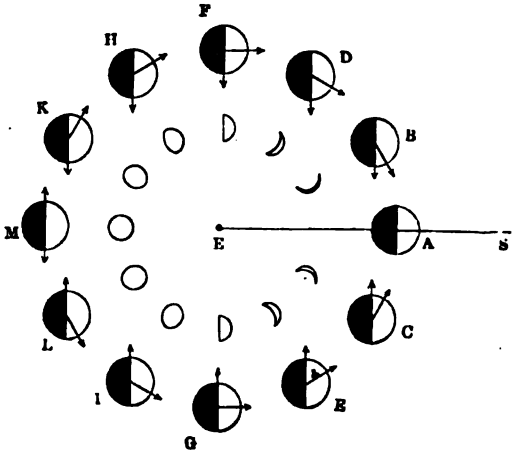
Predicted R.A. h	m	s	Observed R.A. h	m	s	Difference.
14	23	57·87	14	23	57·61	26-100ths of a second.
23	1	59·84	23	1	58·55	1ˢ and 29-100ths.
4	56	13·31	4	56	14·01	7-10ths of a second.
18	7	40·74	18	7	40·50	24-100ths of a second.

The lunar theory then, resting upon the Newtonian doctrine, enables astronomers to find the position of the moon within a part of the heavens answering to a second of diurnal revolution, while the rough observations with which astronomy must always commence would not give the length of a lunation within an hour. It is also confidently expected that the lunar tables recently computed by Professor Hansen of Gotha, in accordance with his lunar theory, and printed at the expense of the British government, will, from their superiority, ensure a degree of accuracy of prediction hitherto unprecedented.

Taking the lunar phenomena in the order of discovery, we next notice that this planet writes its mark on the earth in terms which have been understood from the earliest ages of astronomical inquiry. The alternate rise and fall of the waters, called the *tides*, is found to follow its motions, so that high water is always found to succeed the time when the moon comes on the meridian, whether on the visible or invisible side of it. At first sight it would appear that there is high water twice a-day (that is, in the common solar day), but it is found on further examination that the interval between high water and high water is a little more than twelve hours; so that in the year 1858 that phenomenon occurred only 705 instead of 730 (twice 365) times. Now the motion of the moon round the heavens is found to take place (one time with another) in 27·32166142 solar days (we shall presently see why this is not a lunation), which gives 13° 10′ 35″ increase of right ascension in each solar day, or 13° 8′ 23″ in a sidereal day, or actual revolution of the earth. Hence the meridian of the spectator, between two times at which the moon is on the visible side of that meridian, must make so much more revolution as is necessary to overtake a body which revolves through 13° 8′ 23″ while it revolves through 360°; which gives 24ʰ 55ᵐ of a revolution of the earth for each lunar day, or 12ʰ 27½ᵐ for its half. Now the year contains 366¼ *sidereal* days, or simple revolutions of the earth; and it will be found that 12ʰ 27½ᵐ is contained 705 times and a fraction in 366¼ᵈ. As every reader may not be acquainted with the distinction of sidereal and solar time, we may here simply state (referring to SUN and TIME for detail) that the common day is not the simple revolution of the earth, but includes the additional time in which the meridian overtakes the sun, which has moved forward about a degree. Thus it appears, that even on a single year the coincidence of half a lunar day and the interval between two times of high water is sufficiently apparent. It may be said that we have assumed the question by counting the times of high water from an almanac constructed on the supposition which we wished to establish. This would be true if we had talked of the year 1860; but we may consider an almanac for 1858 as now a verified prediction: it would have made no small noise in the public papers if there had been a tide more or less in the Thames than was predicted in the almanacs. The theory of the tides is the most difficult in astronomy, owing to the disturbing action of winds, channels, &c., as well as its intrinsic mathematical difficulties; but this one phenomenon has never had its exception in open sea—that every transit of the moon over (either side of) the meridian is followed by the rise of the water, though so high a wind has been known as to prevent the tide coming up a river.

We return to the phenomena of the *phases* (Greek for appearances), as they are called, of the moon, namely, the changes in the quantity of its illuminated part. These may be immediately explained on the supposition that the moon is not luminous itself, but receives its light from the sun.

To show how this may be, suppose a ball, illuminated by another ball at a great distance in the direction ES, to be carried round the spectator at E. This ball may be always subdivided into a visible and invisible half, since one-half must hide the other in all positions. But it may also be divided into an illuminated and unilluminated half. At A the visible half is all unilluminated, and though we have called it the visible half (meaning in a position to be seen, if there were light), it will not be seen. But when the ball arrives at B, a small portion of the illuminated half is in the visible half, as much as is intercepted between the arrows. At D a larger portion of the illuminated part is visible, and at F a full half of the visible surface is illuminated. A little consideration of this scheme (which is moreover explained in all popular works) will show not only the occurrence of phases precisely similar to those of the moon, but also that the circular boundary of the enlightened part is towards the illuminating body. We copy from Riccioli his collection of the Latin and Greek terms used with respect to the different phases:—



A Novilunium, luna silens, Conjunctio, Congressus cum sole, Neomenia, Synodus, Lunæ accensio.	νεομηνία νουμηνία σύνοδος
B Prima phasis, Nova luna.	πρώτη φάσις νέα σελήνη
C Ultima phasis.	ἐσχάτη φάσις ἕνη σελήνη
Luna novissima, Interlunium, seu intermenstruum, est tempus inter ultimam et primam phasim, à C ad B.	ἀφανισμὸς

B, C, D, E, Corniculata, Falcata, curvata in cornua.	μηνοειδὴς
D Primus sextilis aspectus, et E secundus.	ἑξαγώνος
F Prima Quadratura, G secunda; luna dividua, bisecta, dimidiata, semiplena.	τετράγωνος διχότομος ἡμίτομος
H, K, L, I, Luna Gibba, gibbosa; H primus, I secundus aspectus trinus; Luna in triquetro.	ἀμφίκυρτος τρίγωνος
M Plenilunium, Oppositio, Luna Totilunis, in diametro sinuata in orbem, medius mensis.	πανσέληνος διχομηνία
Luna crescens ab A per F in M, Luna descrescens seu senescens ab M per G in A.	σελήνη αὐξανομένη σελήνη φθίνουσα

If the moon moved in the plane of the ecliptic, or of the sun's motion, as in the figure, there would be an eclipse of the sun at every new moon (A), and of the moon at every full moon (M); since in the former case the moon would hide the sun, and in the latter the earth would intercept the sun's light. The moon however is generally a little on one side or the other of the ecliptic, not enough to introduce any sensible error into the preceding explanation of the phases, but enough to hinder the eclipses from taking place, except now and then: we shall see more of this presently. Again, if the sun remained in the line E S, the lunation, or complete cycle of phases, would be of the same duration as the actual revolution of the moon round the heavens. Since however the sun moves slowly forward in the same direction as the moon, the latter does not alter its phases so rapidly as in the figure, nor is the cycle of phases complete until the moon has overtaken the sun.

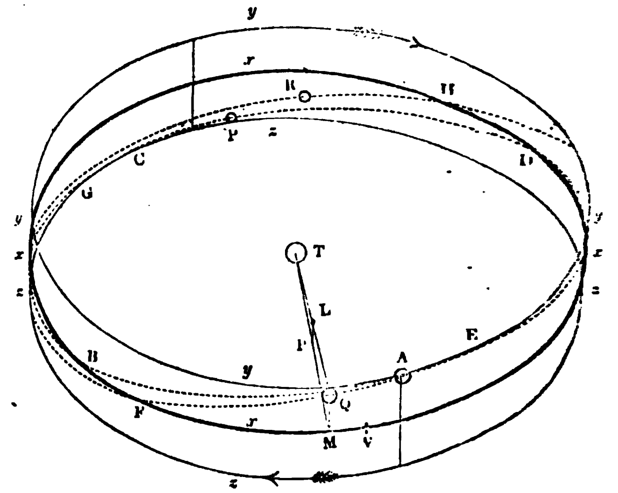
It is usual to divide the whole lunation into four quarters, the first from new moon to increasing half moon, the second from half moon to full moon, the third from full moon to waning half moon, the fourth from half moon to new moon. Each of these is called the change of the moon, and it is a very common belief that a change of weather and wind is to be expected, if not at every change of the moon, at least much oftener at the changes than in the intervals. This opinion, when not absolutely received as true, is usually treated as the extreme of absurdity. It is in truth neither one thing nor the other, as the following considerations will show.

The atmosphere is continually undergoing a slight alteration from the effects of the tide. At new and full moon (or rather a little after these phenomena) there are those great tides called the spring-tides, arising from the action of both luminaries; at the two quarters the same luminaries oppose each other, and the quarters are followed by the smaller floods, called neap-tides. What effect may be produced by this succession of smaller and greater oscillations of the sea, which must produce oscillations of the atmosphere, it is impossible to say beforehand. Again, we know nothing of the electric action of either luminary upon the earth, or whether any and what electric state may depend upon their relative position. We have therefore abundant grounds *à priori* to abstain from forming any opinion upon the effect of the heavenly bodies upon the weather; and we shall now state the results of such facts as observation has furnished. M. Arago collected the evidence on this subject in an article published in the 'Annuaire' for 1833; the general conclusion derived from them is, that upon the whole there is *a little* more rain during the second quarter than during either of the others; but that there is no evidence to confirm the common notion that a change of the moon is accompanied by change of weather. It has also been observed that the height of the barometer is, one time with another, less in the middle of the second quarter than in that of either of the others; and that it is somewhat greater at new and full moon than at the quarters. With regard to a great many other asserted effects of the moon upon animal and vegetable life, it can only be said that there is no conclusive evidence for or against them; nothing but a long series of observations can settle such points, and this is not likely to be made (or if made, to be made fairly) by those who have predetermined the questions in one way or the other.

The moon's age is usually reckoned from the new moon, and the rules by which Easter is found depend, or should depend, upon a correct knowledge of this age at the beginning of the year, called the EPACT. But all readers should remember that the sun and moon by which Easter is found are not the real bodies, but fictitious ones, moving not with the real but the average motions, and therefore sometimes before and sometimes behind the real bodies. It should then be no matter of surprise if, as will happen, Easter Sunday should sometimes be seven days sooner or later than it would be if the real bodies were employed. [EASTER, METHOD OF FINDING.]

We now come to the actual motion of the moon round the earth, which is the most complicated question in astronomy. Roughly speaking, it may be said that the moon's motion is circular, which is sufficient for the explanation of the phases; it is somewhat, but very little, more correct to say it is elliptical. If the moon's orbit were actually exhibited in space, an ellipse might be found which would nearly fit one of its convolutions; but the succeeding convolutions would depart further and further from such an ellipse, and it would be nineteen years before a convolution would again occur which is situated in space near to the ellipse with which we started. And though astronomers have found a way of simplifying the question, by supposing the moon to move in an ellipse which itself moves in space, yet we may better explain the subject by arriving at that ellipse from the real motion than by beginning with it.

When the motion of the moon is watched in the heavens with instruments fitted to measure her apparent diameter, it is soon found that she changes her distance from the earth, becoming alternately larger and smaller. Her path is not very much inclined to the ecliptic, so that she is never 5¼° from some one of the positions which the sun has had or will have in the course of the year. We may explain the *apparent* path in the heavens by the annexed figure, which represents a portion of the apparent heavens: T is the earth in the centre; *xxxx* is the circle of the ecliptic; *yyyy* and *zzzz* are small circles parallel to the ecliptic, and each distant from it in the heavens by an angle of 5° 8' 47"·9. The moon may rise 8' 47"·15 above *xxxx*, or fall as much below *zzzz*; but these two circles are chosen because they are mean: that is to say, for every convolution which rises above *xxxx* there will be another, described at some other time, at which it falls short of *xxxx*; so that in a long series of years the sum of all the arcs by which convolutions rise above *xxxx* would be equal to the sum of those arcs by which other convolutions do not attain *xxxx*. The angle 5° 8' 47"·9 is, in the astronomer's elliptic fiction, the mean inclination of the orbit to the plane of the ecliptic. The dotted line A B C D E F G H is one complete convolution of the orbit and the greater part of another. We suppose the moon to set off from its highest point (high and low have reference to the ecliptic) A, at or very near *yyyy*: thence it falls to the descending node B, and continues to descend to its lowest point C, whence it rises to the ascending node D, and thence ascends to E, thence to the next descending node F, thence to G, the lowest point (at or near *zzzz*), and to the next ascending node H, &c. In this way the whole of the lunar zodiac is interlaced with the convolutions of its orbit, which go on for ever; nor have we any reason to suppose that the cycle of convolutions is ever complete, so as to begin again.



The first thing we have to notice is what is called the regressive motion [MOTION] of the nodes. The first node we meet with is B, and the next, D, is not exactly opposite to B, but a little behind the opposite point; the next, F, is still more behind B. The words before and behind have reference to the direction of the motion. This recession of the node amounts, one year of 365 days with another, to 19° 19' 42"·316, and the node makes a complete retrograde revolution in 6793·39108 mean solar days, or 18·6 years nearly. The point in which the moon ascends through the ecliptic falls back more than twice the moon's diameter in each revolution. The amount, however, is subject to some variation; that given above is its average.

Again, the apparent diameter of the moon is observed to vary, owing to an alteration of her distance from the earth. When least, it is 29' 2"·91; when greatest, 33' 31"·07. But it is observed that the least and greatest diameters of a single revolution are not exactly the same as those of another revolution; and also that the place where the diameter is least is not exactly opposite to that in which it is greatest, but always in advance. Thus the diameter, being greatest at A, becomes least at P, in advance of the point opposite to A, greatest again at Q (in advance of A), and least again at R. Now the apparent diameter must be least when the distance is greatest, and *vice versâ*; the point of a convolution most distant from the earth is called the apo-gee, that nearest to the earth the peri-gee. There is, then, a progression of the apogee, and its average quantity is no less than 6' 41" for each solar day, or 40° 39' 45"·36 in 365 days, which is equivalent to a complete revolution in 3232·575343 mean solar days, or about nine years. The quantities above given are averages, for the actual progression is irregular.

We may notice, then, five distinct species of months:—1. The average sidereal month, or complete circuit of the heavens. 2. The average lunation, common month, or interval between two conjunctions with the sun. 3. The average *anomalistic* month, or revolution from perigee to perigee. 4. The average tropical month, or from the vernal equinox to the vernal equinox again (the equinox being in retrograde motion [PRECESSION]). 5. The average nodical month, or from a node to a node of the same kind. The quantities of these months are as follows (Baily, 'Astron. Tables and Formulæ') in mean solar days:—

	d	h	m	s		d
Sidereal month . . .	27	7	43	11·5	or	27·32166142
Lunation	29	12	44	2·9	,,	29·53058872
Anomalistic month . . .	27	13	18	37·4	,,	27·55459950
Tropical month	27	7	43	4·7	,,	27·32158242
Nodical month . . .	27	5	5	36·0	,,	27·21222222

If we compare the lunation with the common year, we shall find that 235 lunations make 6939·69 days, while 19 years make 6939 or 6940 days, according as there are four or five leap-years in the number. Neither is wrong by a day; consequently in 19 years the new and full moons are restored to the same days of the year. This does not absolutely follow, either from the preceding or from the method which gave it, since neither is the coincidence exact, nor are the months exactly equal. But it will generally so happen; and this is the foundation of the *Metonic Cycle*. [CALIPPUS and METON, in BIOG. DIV.] Again, 223 lunations make 6585·322 days, and 242 nodical revolutions make 6585·357 days, so that there is only ·035 of a day, or 50 minutes, difference between the two. This period of 223 lunations is the SAROS, a celebrated Chaldean period, and contains in round numbers of days 18 years and 10 days, or 18 years and 11 days, according as there are five or four leap-years. It may be worth while to express these numbers of lunations in terms of the other months.

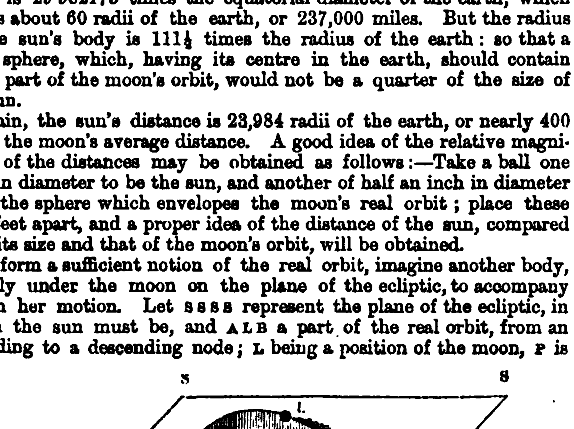
Metonic Cycle.—235 lunations make 253·999 sidereal months, 251·852 anomalistic months, and 255·021 nodical months.

Saros.—223 lunations make 241·029 sidereal months, 238·992 anomalistic months, and 241·999 nodical months.

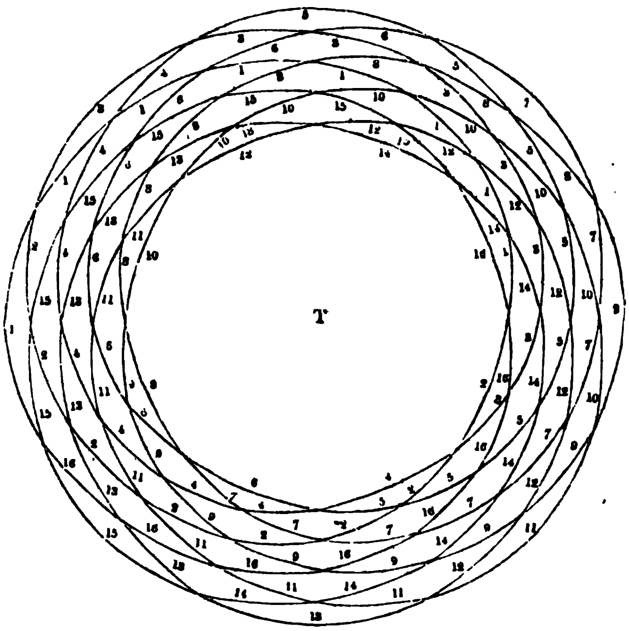
The rate at which the moon moves is different in different parts of the orbit. We may speak either of the rate at which she changes longitude, latitude, or distance from the earth; and owing to the smallness of the inclination of her path to the ecliptic, her motion in longitude is nearly the same thing as her motion in her own orbit. The quickest motion is at or near the perigee, and the slowest at or near the apogee. The moon's rate of motion follows no easily obtainable law in its changes, which are different in different months. The rate of change of latitude is greatest near the nodes, and the rate of change of distance from the earth is least at the apogee and perigee, and greatest at and about the intermediate points. We have hitherto considered the apparent path of the moon among the stars: we now pass to the real orbit in space. Her average distance from the earth is 29·982175 times the equatorial diameter of the earth, which makes about 60 radii of the earth, or 237,000 miles. But the radius of the sun's body is 111½ times the radius of the earth: so that a large sphere, which, having its centre in the earth, should contain every part of the moon's orbit, would not be a quarter of the size of the sun.

Again, the sun's distance is 23,984 radii of the earth, or nearly 400 times the moon's average distance. A good idea of the relative magnitudes of the distances may be obtained as follows:—Take a ball one inch in diameter to be the sun, and another of half an inch in diameter to be the sphere which envelopes the moon's real orbit; place these nine feet apart, and a proper idea of the distance of the sun, compared with its size and that of the moon's orbit, will be obtained.

To form a sufficient notion of the real orbit, imagine another body, directly under the moon on the plane of the ecliptic, to accompany her in her motion. Let S S S S represent the plane of the ecliptic, in which the sun must be, and A L B a part of the real orbit, from an ascending to a descending node; L being a position of the moon, P is the projected body on the plane of the ecliptic; and the motion of P will be very nearly that of L, owing to the smallness of the rise of A L B above the plane of the ecliptic. The motion of the projected body will then be of the kind of which the following diagram is an exaggeration.



Suppose the moon to set out from 1 on the left, being then in apogee, and also at a node: the projected body will then describe 1 1 1, &c., until it comes to its perigee at the first 2, which is in advance of the point opposite to the apogee. But the real moon will have come to the plane of the ecliptic before it is opposite to the first 1, so that at the first 2 the moon will be below the projected orbit. The projected body then describes 2 2 2 . . . up to the next apogee 3, and so on; the real moon having come above the ecliptic before the last 2 but one. In the present figure the number of folds is limited, and the last joins the first; in the moon's orbit the number of folds is unlimited. The real relation between the greatest and least distances is slightly variable in the different folds; one with another it may be thus stated: 5½ per cent. being added to the mean distance will give the greatest or apogean distance, and subtracted, the least or perigean distance. Taking the fiction of the moving ellipse for the moon's orbit, its eccentricity is ·0548442.



In the article GRAVITATION will be found a sketch of the producing causes of the inequality of the lunar motions, showing that they arise from the effect of the sun's unequal attraction of the earth and moon; were it not for which, the latter would describe an ellipse round the former. In the present article we intend only to describe the motions themselves. We have pointed out both the apparent orbit in the heavens, and the real orbit: It remains to ask, In which manner is the real orbit described? At a given time, how is the moon's place in the heavens to be ascertained?

Returning again to the apparent orbit, we first consider motion in longitude only; that is we ask how to find the moon's longitude at the end of a given time. Let us suppose then that, Q being the apparent place of the moon in the heavens, we draw Q M on the sphere perpendicular to the ecliptic, so that M has the same longitude as Q. To connect this figure with the last, suppose that the moon was at L when it was projected in the heavens to Q, and let P be the projection of L on the ecliptic: then P will be thrown upon M in the heavens. The average motion of M will be that of the moon, or a circuit in 27·32166 days. If then we were to suppose a fictitious moon setting out from M, and moving with this average motion, it would never be far from the point M; which last, from the irregularity of the real moon's motion, would be sometimes before and sometimes behind the fictitious moon.

If we could observe the fictitious moon, thus regularly moving in the ecliptic (say every day at midnight), and also the real moon, we might take a long series of years' observations, and sum all the excesses of M's longitude over that of the fictitious body, when there are excesses, and all the defects when there are defects. We might expect to find the one sum equal to the other; but we are taught by the theory (which, as before seen, is exact enough to find the moon's place within a second) that the equality of these sums will not be absolutely attained in any series of years, however great, if we take the commencing point, at which M is to coincide with the fictitious body, at our own caprice. Wherever Q may be, there is a proper place for this fictitious moon, before or behind M, from which if we allow the former to start, the longer we go on with the series of supposed observations, the more nearly will the excesses balance the defects; supposing always that our series of observations stops at the end of a complete number of circuits, and not in the middle of one. This position is called the *mean place* of the moon, as distinguished from Q, its *real place*. Let us suppose it to be at V; then if the average moon start from V, with the moon's average motion, it will at every instant of time point out what is called the mean place of the moon corresponding to the then real place. At the commencement of the present century, that is, when it was 12 o'clock at Greenwich on the night of December 31, 1800, the longitude of the average moon, or the moon's mean longitude, was (according to Burckhardt) 118° 17′ 3″;

and the mean longitude at any other time is found by adding in the proportion of 4809°·38468 for every 365 days, and making the necessary additive allowance for the precession of the equinoxes. [Precession.]

In the same way the node and perigee of the moon have their mean places, and, as we have seen, their mean motions. The mean longitude of the perigee, at the commencement of the century, was 266° 10′ 7″·5; that of the ascending node 13° 53′ 22″·2.

To the above must be added that these average motions, as they are called, are subject to a slight acceleration, which hardly shows itself in a century; that of the longitude was detected by Halley from the comparison of some Chaldean eclipses with those of modern times. This acceleration would, in a century, increase the mean longitude of the moon by 11″, that of the perigee by 50″, and that of the ascending node by 7″.

The mean longitude being ascertained for the given time, the true longitude is found by applying a large number of corrections, as they are called, some determined from the theory of gravitation, but the larger ones, as might be supposed, detected by observation before that theory was discovered, and since confirmed by it. Into this subject it will be impossible to enter at length; we shall therefore merely instance a few of the principal corrections for the longitude, observing that the latitude, the distance, &c., are all determined by adding or subtracting a number of corrections from the results of the supposition that the moon moves uniformly in the ecliptic at her average distance from the earth.

The first correction is one which brings the motion nearer to an elliptical one, and is called the *equation of the centre*. It depends upon the moon's distance from her perigee, called the anomaly. The *mean* anomaly is the distance of the moon's mean place from that of the perigee. The mathematical expression is (we give only rough constants)—

$$6^\circ\, 17' \times \sin \text{(mean anomaly)}.$$

The second correction, known as the *evection*, and discovered by Ptolemy, is—

$$1^\circ 16' \times \sin \left\{ 2\,(☾ - \odot) - \text{mean anomaly} \right\}$$

where ☾ and $\odot$ stand for the mean longitudes of the moon and sun.

The *variation* and the *annual* equation (discovered by Tycho Brahé) are represented by

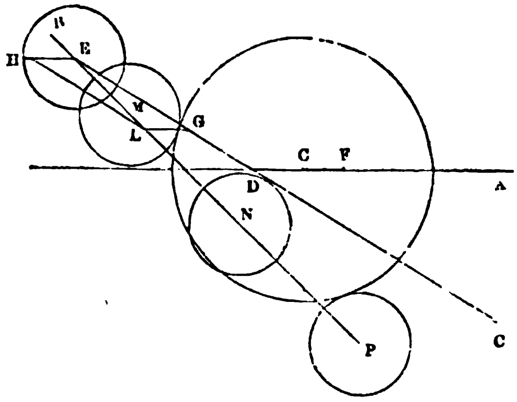
$$39' \times \sin 2\,(☾ - \odot)$$

and $$11' \times \sin\,(\odot\text{'s mean anomaly.})$$

Many such corrections (but those which remain, of less amount) must be added to or subtracted from the mean longitude before the true longitude can be determined.

Having thus noticed the actual motions of the moon, we proceed to the phenomena of eclipses, and of the harvest-moon, as it is called. An eclipse of the moon has now lost most of its astronomical importance, and can only be useful as an occasional method of finding longitude, when no better is at hand. Eclipses of the sun, observed in a particular way, may be made useful in the correction of the theory both of the sun and moon; in this case matter is absolutely hid from view by matter, and the moment of disappearance can be distinctly perceived. But in the case of the moon, which is eclipsed by entering the shadow of the earth, the deprivation of light is gradual; so that it is hardly possible to note, with astronomical exactness, the instant at which the disappearance of the planet's edge takes place.

In a lunar eclipse the first thing to be ascertained is the diameter of the earth's shadow at the distance of the moon. Suppose this shadow, that is, its section at the distance of the moon, to be represented by the circle whose centre is C: it is directly opposite to the sun, its centre is on the ecliptic, and moves in the direction of the sun's general motion, or from west to east.



Let C A be the ecliptic, and let B C be a part of the moon's orbit, with the node at D. It must be remembered that the whole takes place on a very small part of the sphere, so that all the portions of the orbits which actually come into use may be represented by straight lines. Let the centre of the moon be at E when that of the shadow is at C; and let the hourly motions of the sun (that is, of the shadow) and of the moon be C F and E G. If then we communicate to the whole system a motion equal and contrary to C F [Motion], the shadow will be reduced to rest, and the relative motion of the moon with respect to it will remain unaltered. Take E H equal to C F, and contrary in direction; then E L will represent the quantity and direction of the hourly motion of the moon relatively to the shadow at rest. By geometrical construction therefore, M, N, and P may be ascertained, the positions of the moon's centre at the beginning, middle, and end of the eclipse; and E M, E N, and E P, at the rate of E L to an hour, represent the times elapsed between that of the moon being at E and the phenomena in question. Such is the geometrical process: the one employed in practice is algebraical, and takes in several minor circumstances which it is not worth while here to notice.

An eclipse of the moon is a universal phenomenon, since the moon actually loses her light, in whole or in part; while in an eclipse of the sun, the moon hides the sun from one part of the earth, but not from another. The former can only take place when the conjunction (or sameness of longitude) of the moon and earth's shadow, that is, the opposition of the sun and moon, or the full moon, happens when the moon is near her node. [Eclipse; Sun; Saros.] For the phenomena of the occultation of a star by the moon, see Occultation.

By the *harvest-moon* is meant a phenomenon observed in our latitudes at the time of the full moon nearest to the autumnal equinox, when it happens for a few days that the moon, instead of rising fifty-two minutes later every day, rises for several days nearly at the same time. Something of the same sort takes place always when the moon is near her node; but the circumstance is most remarkable when it happens at the time of greatest moonlight. The reason is that the increase of declination (which is most rapid when the moon is near the equator, which she must be when full moon comes nearly at the time of the equinox) compensates the retardation which would otherwise arise from her orbital motion. [Sphere.] See the treatise above cited, pp. 80, 81.

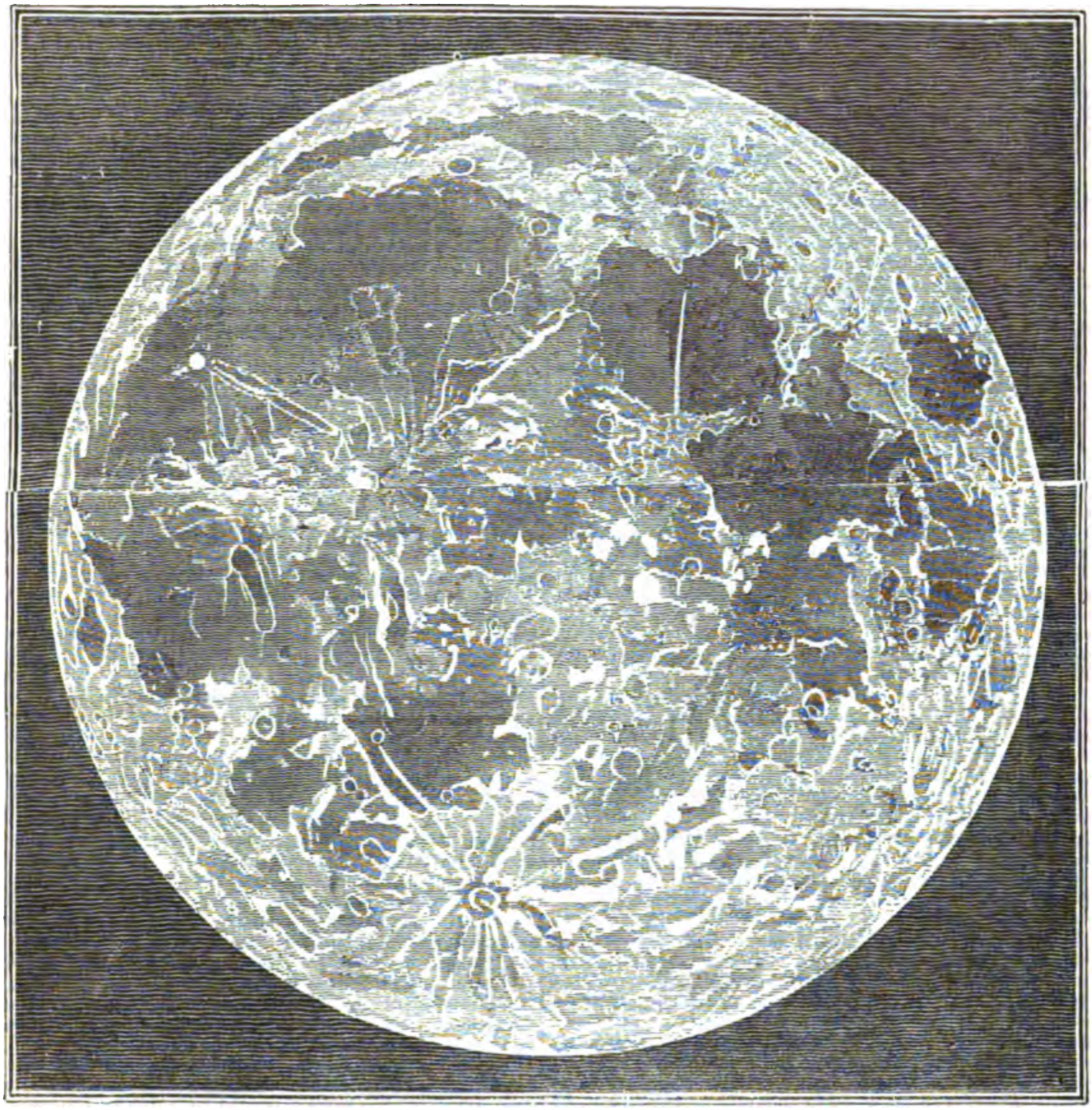
The discovery of the telescope, and the examination of the moon which followed, soon showed that the planet always turns the same face towards the earth, or very nearly. From hence it immediately follows that the moon must revolve round an axis in the same time as that axis revolves round the earth. If any one should walk round a circle without turning himself round, that is, keeping his face always in the same direction, he would present alternately his front and back to the interior of the circle. But if he desires to turn his face always inwards, he must turn round in the same direction as he walks round. [Motion, Direction of.] If the moon moved uniformly round in her orbit, and had a uniform rotation of the same duration, then if her axis were perpendicular to the plane of the orbit, and the spectator were always at the earth's centre, the face of the moon would be always actually the same. None of these suppositions are true. 1. The motion in the orbit is irregular, while the rotation is uniform and exactly the sidereal month: the consequence will be that when the moon is moving quicker than the average, a little of the western side will be coming into view, and a small portion of the eastern side will be disappearing, and *vice versâ*. 2. The axis of the moon is not perpendicular to her orbit, but is out of the perpendicular by an angle of 5° 8′ 49″; the consequence is, that as she revolves in her orbit, the north and south poles of the moon will alternately become invisible, each during half a revolution. 3. The spectator is in motion round the earth's axis, which will slightly vary the part seen of the moon in the course of the day. These effects are called librations: (1) the libration in longitude, (2) the libration in latitude, (3) the diurnal libration. The second will be elucidated in Seasons, Change of, and the third in Precession and Nutation.

The way in which we know that the face presented is always nearly the same, is by observation of that face, which is varied by numberless spots and streaks. The following cut represents the general appearance of the moon at full, being a view of its average face in the mean state of libration, that is to say, no part of the present edge is ever hidden by libration without as much of the opposite edge being hidden at some other time.

It may here be mentioned that photography has been applied to the production of views of the lunar surface with great success. Among these, the beautiful photographs by Professor Bond in America, and Mr. Warren De La Rue in this country, hold a distinguished place. Indeed the stereoscopic views of the moon in different states by the latter gentleman, leave but little to be done by succeeding photographers, their effect being such as to excite the surprise and admiration of all by whom they are viewed.

For particulars respecting the spots on the moon, the reader is referred to a work lately published by the Rev. T. W. Webb, entitled 'Celestial Objects for Common Telescopes.' In this little work, which contains a vast amount of information on practical subjects, a map of the moon is given, exhibiting the places and delineations of 404 of the principal craters and other appearances on the lunar surface carefully reduced from the large map published by Beer and Mädler, and verified for the most part by actual observation.

Casual observers of the lunar surface must however bear in mind, that the figure of a spot varies exceedingly according to the degree of its illumination. Thus many spots and appearances that are strongly marked in the increasing or waning moon are almost if not entirely invisible at the time of full moon. They also vary greatly at different periods of the lunation, and the alteration in some is so great that they are with difficulty recognised as the same spots. Many astronomers are consequently at the present time engaged in following and delineating the appearance of certain spots through the whole period of a lunation, and thus it is hoped future observers may be enabled to verify them at any time during that period. This if fully carried out would be a most valuable boon to persons engaged in lunar investigations, as every variation arising from the before-mentioned causes would be readily recognised; and should any actual alteration take place in any of these craters, a thing that has repeatedly been suspected, it could not fail in being immediately detected.



The names of the spots were first given by Riccioli, and his nomenclature is still generally followed, although with very numerous additions. The spots are distinguished by the names of eminent astronomers, philosophers, and mathematicians, both ancient and modern, as Eratosthenes, Plato, Pythagoras, Archimedes, Tycho, Copernicus, Kepler, &c. Many of these spots deserve a more particular notice. Thus Tycho, the large crater in the centre of the lower part of the cut, is remarkable, not only on account of its brilliancy and size, (being 54 miles in diameter, and in depth 16,600 feet,) but also for the radiating streaks, which proceed from it in all directions, some of which extend into the opposite hemisphere. Copernicus, a conspicuous spot to the left of the cut, and about half way to the top, presents an immense crater, 56 miles in diameter, in the centre of which is a mountain having six peaks, of which two are very conspicuous. It is surrounded by a ring composed of successive terraces, ending in a narrow ridge, and rising to the height of 11,000 feet from the bottom of the crater. Aristarchus, the spot still more to the left above Copernicus, is the brightest crater in the moon; it is so brilliant as to be quite dazzling in a large telescope. It is this spot that was supposed by Sir William Herschel to be a volcano in eruption. Plato, a large dark oval spot in the upper portion of the cut, is remarkable for having the bottom of the crater striped, which is also the case with Archimedes, a large oval spot at no great distance from Plato, in which seven nearly parallel stripes may be easily distinguished. Near Plato is a remarkable insulated pyramidal mountain or rock called Pico, rising from a narrow base to about 7000 feet above the surrounding plain, from which it must present a most magnificent appearance. Eratosthenes, a crater situated near a ridge of lofty mountains called the Apennines, is also a very brilliant object, and Stadius, a neighbouring crater, is one of those to be seen only under peculiar illumination, being absolutely invisible at the time of full moon.

The surface of the moon exhibits a very large number of mountains "almost universally of an exactly circular or cusp shaped form, foreshortened however into ellipses near the limb; but the larger have for the most part flat bottoms within, from which rises centrally a small, steep, conical hill. They offer in short, in its highest perfection, the true *volcanic* character, as it may be seen in the crater of Vesuvius. . . . . . And in some of the principal ones, decided marks of volcanic stratification, arising from successive deposits of ejected matter, may be clearly traced with powerful telescopes. What is moreover extremely singular in the geology of the moon is, that although nothing having the character of seas can be traced (for the dusky spots which are commonly called seas, when closely examined, present appearances incompatible with the supposition of deep water) yet there are large regions perfectly level, and apparently of a decided alluvial character." (Sir J. Herschel, 'Astronomy,' p. 229.) The mountains are known by their shadows, which are perfectly visible, and which are long when they are near the boundary of light and darkness, or when the sun is in the horizon, and disappear when they are 90° from that boundary, or when the sun is overhead. We copy from Schroeter's 'Selenotopographische Fragmente' two representations of the spot Archimedes, the first when very near the dusk part, the second when far from it.

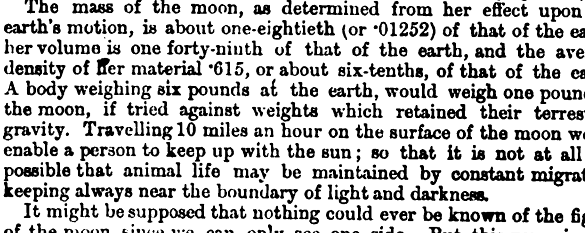
By the help of these shadows, as well by other means, the heights of many of the lunar mountains have been measured, and some have been found whose heights exceed a mile and a half.

From the manner in which the moon is seen, as well as from the stars, when she approaches near them, undergoing no refraction whatever, it is certain that she has either no atmosphere, or one of a degree of tenuity which must exceed, perhaps, that of the best exhausted receiver. From this it has been inferred that there are no fluids at the surface of the moon, since, if there were, an atmosphere must be formed by evaporation. It is however enough to say that the fluids, if such there be, must be very different from those which abound at the surface of the earth. Since the moon has a day (with reference to the sun) of a whole sidereal month in duration, each part is $14\frac{3}{4}$ days in sunlight, and $14\frac{3}{4}$ days without it. The intense heat and cold which must thus alternate would destroy human life, even on the supposition that terrestrial vegetation could be maintained. The fluid on the warm side (if any) must be constantly evaporating and passing off to the colder side. "The consequence must be absolute aridity below the vertical sun, constant accretion of hoar frost in the opposite region, and perhaps a narrow zone of running water at the borders of the enlightened hemisphere. It is possible, then, that evaporation on the one hand, and condensation on the other, may, to a certain extent, perserve an equilibrium of temperature, and mitigate the extreme severity of both climates." (Sir J. Herschel, 'Astronomy,' p. 230.)

The mass of the moon, as determined from her effect upon the earth's motion, is about one-eightieth (or ·01252) of that of the earth, her volume is one forty-ninth of that of the earth, and the average density of her material ·615, or about six-tenths, of that of the earth. A body weighing six pounds at the earth, would weigh one pound at the moon, if tried against weights which retained their terrestrial gravity. Travelling 10 miles an hour on the surface of the moon would enable a person to keep up with the sun; so that it is not at all impossible that animal life may be maintained by constant migration, keeping always near the boundary of light and darkness.

It might be supposed that nothing could ever be known of the figure of the moon, since we can only see one side. But this very circumstance leads us to some knowledge on the point. It is impossible to believe that the moon should revolve on her axis precisely in the same average time as she revolves round the earth, without half a second of difference, and not to suppose that there is some mechanical connection between the two revolutions, so that either one is a consequence of the other, or both are consequences of some common cause. As this subject is rarely elucidated in elementary treatises, we have somewhat abridged several of those topics which are usually treated, in order to supply considerations for which we could only refer to treatises of the most mathematical character.

It is well known in mechanics that the rotation of a body is in no way affected, if we suppose its centre of gravity to be fixed instead of moveable, provided the same forces act in both cases. Thus if a stick be tossed into the air (or rather into vacuum) by an impulse communicated to a similar stick which revolves on its centre of gravity, the first in its combined rotation and translation, and the second in its rotation only, will always remain parallel to each other, if they were so at first. Let us now suppose a needle placed on a point, and magnetic, round which a ball of iron revolves from A. If the needle be first at rest, then when the ball moves towards B, it will endeavour to draw the needle towards the position O N, and the needle will begin to revolve in the same direction as the ball. Suppose that by the time the needle points to O N, the ball is at O C, O C and O N being perpendicular; the ball then acts equally on both sides of the needle, and all acceleration of the rotation stops. When the ball arrives at D, it is tending to destroy its former effect, pulling the end P towards it. It may thus be seen that if the needle were heavy enough, the ball would by its motion cause an oscillation, working to produce rotation in one direction during half its revolution, or rather more, and the opposite effect during rather more than another half revolution, in alternate quarters. But if the needle were light enough, it is easily seen that the rotation in the first direction might be produced so rapidly, that the second mode of action should never be exerted, or the revolving ball should never so far outstrip the needle that N O C should become a right angle. In this case the action would go on in one direction until the needle would acquire a rotation equal to and even exceeding that of the ball. But in the latter case, when the needle overtakes and passes the ball, the opposite action would be immediately exerted, and the acceleration of rotation would be checked. The end would be, that the needle would acquire a rotation equal to that of the ball, on the average, and would revolve so as always to present its point either to the ball, or alternately a little on one side and on the other. The same effect would be produced if the needle, at the commencement, had a rotation nearly equal to that of the ball; the consequence would be, that the action in one direction would continue long enough to establish permanent equality of the average rotations. Without supposing the moon a long needle, with one end turned towards the earth, it is found by calculation, that it is sufficient to suppose it slightly spheroidal, with the longer axis towards the earth. The same mathematical considerations which have so completely resolved the orbital motions, show that the figure of the moon must be an ellipsoid [SURFACES OF THE SECOND DEGREE] revolving round the shorter axis, and presenting the extremity of the longer axis to the earth. But the proportions of these axes have not been well determined, from want of observations: theory has outrun practice on this point. It is but comparatively lately that even the inclination of the moon's equator to the ecliptic has been determined at 1° 30′ 10″·8; that of the equator to the *orbit* being 5° 8′ 49″, as already noticed.



One more very curious phenomenon has been shown to be of the same kind as the preceding; namely, of the sort which must be made absolutely true by the earth's attraction, if it were nearly true at the beginning. The moon's equator cuts her orbit in a line which is always parallel, or very nearly so, to the mean position, for the time being, of the line of nodes of the moon's orbit. If the axis of the moon's rotation were perpendicular to the ecliptic, this must be the case, for the moon's equator and the ecliptic would then be parallel planes. And the moon's axis being nearly perpendicular to the ecliptic, it may be shown from spherical trigonometry that the two lines in question could not make an angle of many degrees. But the fact observed (by Dominic Cassini, before the theory of gravitation was thought of) is either actual parallelism, or something differing from it by very trivial oscillations. It is difficult to represent this phenomenon to a person unacquainted with geometry. It may be thus stated: the moon's orbit, the ecliptic, and the moon's equator, are three planes which form a triangular prism when produced. Or thus: if the moon were made to revolve rapidly round its axis, and if the earth were made a source of light and heat giving seasons to the moon, as the sun does to the earth, then the nodes of the moon's orbit on the ecliptic would coincide with the equinoxes, and the moon's orbit would be divided into summer and winter paths by the same line as that in which the sun's path cuts the orbit.

A great many miscellaneous phenomena connected with the moon might be collected, for which we have not space. For the light thrown on her surface when eclipsed see REFRACTION; for a remarkable appearance sometimes observed when she passes over a star see OCCULTATION; for her use in finding LONGITUDE see that word.

MOON, ECLIPSE OF THE. [MOON.]

MOON, SUPERSTITIONS RESPECTING THE. Brand, in his 'Popular Antiquities,' gives a long list of lunar superstitions. It was formerly conceived that if hogs were killed when the moon was increasing, the bacon would prove the better in boiling. (See the *Husbandman's Practice, or Prognostication for Ever*, 8vo., Lond., 1664.)

Tusser, in his 'Five Hundred Points of Husbandry,' under February, says:—

> "Sowe peason and beans in the wane of the moon,
> Who soweth them sooner, he soweth too soon;
> That they with the planet may rest and rise,
> And flourish with bearing most plentiful wise."

In Decker's 'Match me in London,' act i., the king says, "My lord, doe you see this change i' th' moone? Sharp hornes do threaten windy weather."

Werenfels, in his 'Dissertation upon Superstition' (Transl., 8vo., Lond., 1748), p. 6, speaking of a superstitious man, says, "He will not commit his seed to the earth when the soil, but when the moon requires it. He will have his hair cut when the moon is either in Leo, that his locks may stare like the lion's shag; or in Aries, that they may curl like a ram's horn. Whatever he would have to grow, he sets about it when she is in her increase; but for what he would have made less, he chuses her wane. When the moon is in Taurus, he never can be persuaded to take physic, lest that animal, which chews its cud, should make him cast it up again. If at any time he has a mind to be admitted into the presence of a prince, he will wait till the moon is in conjunction with the sun, for 'tis then the society of an inferior with a superior is salutary and successful."

Aubrey, in his 'Miscellanies,' says, "At the first appearance of the new moon after New Year's Day (some say any other new moon is as good), go out in the evening and stand over the spars of a gate or stile, looking on the moon, and say—

All hail to thee, moon, all hail to thee,
I prith'ee, good moon, reveal to me
This night who my husband (wife) shall be.

You must presently after go to bed. I knew two gentlewomen that did this when they were young maids, and they had dreams of those that married them." Dr. Jamieson has quoted these words as used in Scotland, in a different form.

Tacitus, in his 'Manners of the Ancient Germans,' observes that "they hold their meetings on certain days, either at the new or full moon; for they consider these the most favourable times for entering on any business."

Brand quotes Duchesne's 'History of England,' p. 18, where, speaking of the Irish, he says, "Quand ils voyent la nouvelle lune, ils fléchissent les genoux et récitent l'Oraison Dominicale, à la fin de laquelle ils disent à haute voix, addressant leur parolle vers elle, 'Laisse nous aussi sains que tu nous as trouvez;'" which Vallancey confirms in his 'Collectanea de Rebus Hibernicis,' No. xiii., p. 91. "The vulgar Irish at this day retain an adoration to the new moon, crossing themselves, and saying 'May thou leave us as safe as thou hast found us.'" Park observed a similar practice in the interior of Africa among the Mandingoes.

The *Man in the Moon*, one of the most ancient and most popular of our superstitions, is supposed to have originated in the account given in the Book of Numbers, chap. xv., v. 32, &c., of a man who was punished with death for gathering sticks on the Sabbath-day. From allusions by Dante it would seem that the Italians in his day fancied that the man in the moon was Cain with a bundle of thorns (see the 'Inferno' xx. 125-6; Par. ii.) Most nations have their traditions on this subject; Grimm in his 'Deutsche Myth,' has collected a great many.

MOOR, a name given to extensive wastes which are covered with heath, and the soil of which consists of poor light earth, mixed generally with a considerable portion of peat. The want of fertility in moors arises chiefly from a deficiency or superabundance of moisture, the subsoil being either too porous to retain it, or too impervious to allow it to escape. Both extremes occur in some moors, which are parched up in dry weather, and converted into a dark mud by any continuance of rain. A considerable portion of iron in a state of hydrate is also generally found in the soil of moors, which is very hurtful to the vegetation of plants, except heath, furze, and other coarse plants, which almost entirely cover the moors. This iron is carried down through the light surface-soil, and, if it meets with a less porous earth below, is frequently deposited in a thin layer, cementing the particles of silicious sand, which are carried down with it, and forming what is called the *heath-pan* or *moor-band*. This substance is perfectly impervious to water, and wherever it exists in a continuous state, all attempts at improvement are vain, till it is broken through or removed. The roots of trees occasionally find a passage through interstices or fractures of the pan, and then often grow luxuriantly. But wherever young trees are planted, without the precaution of breaking through the moor-band, they invariably fail, and disappoint the expectations of the planter, who, seeing fine large trees growing around, naturally imagined that the soil was peculiarly fitted for them. If the stump of a large tree, which has been cut down, is grubbed up, pieces of the moor-band may often be seen all around the stem, at a short depth below the surface, so arranged as to show evidently that the tap-root, having found an aperture, and extending its fibres downwards into a better soil, has, in swelling, broken the pan and pushed it aside. When the moor consists of a loose peaty earth of little depth incumbent on a rock, as is the case in many mountainous countries, no art can fertilise it. In dry weather the whole surface has the appearance of a brown powder like snuff, which becomes a spongy peat as soon as it is soaked with rain. The hardiest heaths and mosses alone can bear this alternation; and where the substratum of rock is not broken into crevices through which the roots penetrate, all vegetation ceases except mosses and lichens.

In the valleys, where the waters have brought various earths mixed with decayed vegetable matter from the surrounding hills, the substance deposited is mostly peat, which is useful as fuel in proportion to the quantity of bitumen and carbon which it contains. When the peaty matter is mixed with a considerable portion of clay and sand, forming a peaty loam, and a convenient outlet can be found for the superabundant water, it is very capable of improvement, chiefly by draining, burning, and liming. [Barren Land.] As soon as the heath is destroyed by burning it together with a portion of the surface, and the peat-bog has acquired a certain consistency by draining, the application of lime will enable it to produce potatoes and oats, and the peaty matter will soon be converted into a rich soil, abounding in humus, and requiring only repeated cultivation to become extremely fertile. [Peat.] Much judgment is required to know whether a considerable capital may be safely laid out in the improvement of moors. In some cases the return is certain and very considerable; in others the capital is entirely thrown away. Sometimes extensive moors have been converted into flourishing farms of arable and grass land, as in many parts of Scotland and the north of England; sometimes they have been most advantageously planted with forest-trees, and, where there is a great extent of waste and a scanty population, this is generally the most certain mode of improving a property, although the return is slow and distant.

A prudent proprietor, before he begins expensive improvements, will do well to have his wastes carefully examined. The soil and subsoil, and the situation of the springs, should be carefully ascertained by boring in different places to the depth of five or six feet. It will thus appear whether any portion can be readily converted into arable land, or improved as pasture, or whether plantations of trees may be safely made. The division of the waste into fields by deep ditches will often be sufficient to lay them dry; if not, recourse must be had to draining. In the humid climate of Great Britain and Ireland, the water which falls in rains in the winter half of the year is always more than is necessary for healthy vegetation, and ditches are generally indispensable to keep the surface dry. The convenience of enclosures for pasturing cattle and sheep to advantage, added to this, has made the division of wastes by ditches and banks an invariable preliminary to cultivation. Expensive draining may not always be expedient, where the soil is naturally poor; but wherever there is sufficient loam, either immediately under the peat or mixed with it, and lime can be obtained at a moderate cost, the soil may always be brought into cultivation, and will fully repay any judicious outlay of capital.

In many situations on the slopes of hills, or in the valleys, good earth may be found at a moderate depth, which, being carted on the moor, will materially improve the surface. It should be carted out in the beginning of winter, and spread over the surface an inch or two deep. It should be left so a considerable time, especially if there is any appearance of ochre or iron in the earth. The exposure to the air and rain will convert the hydrate or carbonate of iron into an oxide, and thus render it innoxious. The earth also will absorb fertilising portions of the atmosphere, and be much improved. It may then be ploughed in with a shallow furrow, and incorporated with the natural soil by harrowing. A small quantity of lime and manure will bring this mixture into a productive state.

There are many moors which, although incapable of profitable improvement as arable land, may, at a comparatively small expense, be much improved as pasture for sheep and cattle. The principal means of effecting this are, judicious draining by ditches, and enclosing the fields with banks or stone walls, both as shelter for the stock and for convenience of feeding. The heath may be burnt and the ashes spread about, and the surface having been scarified to the depth of a few inches, some grass-seeds suited to the soil and climate may be sown. The surface will soon show a manifest change by the increase of green patches, and a subsequent liming will complete the improvement. When the health of the stock, as well as the increase of food, is taken into the account, it will be found that such an improvement of moorland soon repays the outlay.

When the surface of the ground is very uneven with protruding rocks, interspersed with large stones, the only improvement which can be undertaken is to plant trees, chiefly of the fir or pine tribe, which will grow well if put in judiciously. The plants should be of the last year only, and the ground where they are to be planted should be well examined to find out whether there is a moor-band or rock below. The first must be broken through, which may be done by trenching or by means of heavy-pointed iron bars thrust into the ground with considerable force, wherever a plant is put in. If there is a rock below with six inches of earth over it, provided it be not of a very compact and solid nature, the fir-trees will grow rapidly, and the roots will find crevices to strike into. A plantation should begin in a sheltered spot, and it may be enlarged every year towards the more exposed side. Thus even the highest and bleakest hills may in time be covered with wood, and, if properly managed, cannot fail to be profitable. [Plantations.]

Moss-land is often confounded with moor; but is very distinct in its nature. Moss-land is produced by the accumulation of aquatic plants, and its origin is chiefly vegetable. When it has a considerable depth, and its substance has lost all power of vegetation, it forms peat-bogs of more or less consistency, as the water is drained off or retained in its pores. In the latter case it appears like a spongy vegetable mass, consisting almost entirely of fibres, so interwoven as to form a very light substance, in which water is easily retained, which keeps up a kind of internal vegetation, by which the quantity of the moss is gradually increased. This is the substance which covers the surface of bogs, and where it is of some consistence it allows a passage over them [Bog]; but where it is very thin and loose it deceives the eye by an appearance of solidity, like that of a smooth green pasture, which, however, gives way to the pressure of the foot, and allows it to sink through it with very little resistance. The only way to improve moss is to drain it, and then convert the vegetable matter of which it is composed into soil, by means of lime and pressure. The latter is effected by putting on a considerable quantity of earth, especially sand and gravel, which, incorporating with the moss, consolidates it, and assists the lime in decomposing the vegetable fibre. After this it becomes extremely fertile, producing abundant crops of potatoes and oats; and whenever it has acquired sufficient solidity by the treading of sheep and cattle, it will produce good crops of wheat, or, if laid down to grass, give abundance of hay and pasture. Trees do not thrive in mossy soil, there being too little solidity for the roots, and the large trunks which are frequently found in bogs must have grown before the moss was formed. This may be easily imagined. A wood laid flat by a storm or hurricane may obstruct the natural flow of the waters, and cause them to accumulate. The prostrate trees become surrounded by aquatic plants, which spread their fibres and roots freely through the water, and, decaying, make room for others. Thus the trees are gradually covered and buried in the moss till future generations find them when the moss or bog is explored for fuel or for improvement. The trees which are found buried in mosses frequently show evident signs of having been gradually covered. The upper surface is often decayed and uneven, while the lower shows that it has remained submerged and protected from the contact and influence of the air, and thus preserved from rotting.

MOORISH ARCHITECTURE. [SARACENIC ARCHITECTURE.]

MORAL SENSE is a name which, occurring first in Lord Shaftesbury's 'Inquiry concerning Virtue,' and afterwards adopted by Hutcheson, has since come to be very generally employed to denote the feelings with which we regard men's actions and dispositions. These feelings are known also by the name of feelings of moral approbation and moral disapprobation. This last name answers every purpose which is sought in naming, and is at the same time free from the many objections that may be urged against the phrase *moral sense.*

The phrase *moral sense* is objectionable, first of all, because the feelings for which it is proposed as a name have no analogy whatever to the external senses, from which the phrase is borrowed. The phrase therefore tends to give a wrong notion of the thing for which it is a name, an objection which is of itself altogether fatal to the use of the phrase for the purpose of naming.

A masterly exposition of the objectionableness of the phrase *moral sense,* and of the theories that are founded upon it, will be found in Mr. Austin's 'Province of Jurisprudence determined.' [MORALS.]

MORALITIES or MORAL PLAYS. [DRAMA.]

MORALS is a word used in several different senses, which it is desirable to distinguish. 1. It has been employed, together with the expressions *moral philosophy* and *moral science,* to denote the whole field of knowledge relating primarily to the mind of man; and in this sense it is co-extensive with the word *metaphysics.* To this use of the word there are many objections; and it has accordingly now almost entirely ceased. 2. *Morals,* as well as the expressions *moral philosophy* and *moral science,* denotes specially the science of what is called man's duty, what he ought and ought not to think, feel, say, do. In this sense of the word, morals is one department of metaphysics; mental philosophy, or mental science, or psychology (which, as we shall see presently, is a necessary foundation for morals), being another department. This is in every way the most convenient use of the word, and is now generally sanctioned by custom. In this sense of the word *morals,* it is convertible with *ethics* and with *deontology,* a word coined by Mr. Bentham. 3. *Morals* and *ethics* are at the same time names for the art corresponding to the science which has just been spoken of, the art of performing one's duty, or (as it is generally described) the art of living a good and a happy life. The art and the science being coextensive, and differing only in this, that the same subject-matter is viewed from different points, the indiscriminate application of the same term to both engenders no confusion worthy of notice. 4. *Morals* is, in current conversation, synonymous with *morality;* thus denoting not only the science and the art, but also what is the subject-matter both of the one and of the other.

It is the purpose of this article to give a brief general account of morals, considered as the science of man's duty.

Morals then is a name for the science which teaches what it is man's duty to do and not to do, or (changing the phrase) what he ought and ought not to do; or again, what it is respectively right and wrong for him to do; or (to resort to yet another change of phrase) which teaches what is respectively virtue and vice. Our account of the science must necessarily commence with an explanation of this, its fundamental idea, which is thus expressed in so many different ways.

It is man's duty to do, or he ought to do, or it is right that he should do, or lastly, that is virtue, which, on the most general view possible of the tendencies of a disposition or an action, conduces most to the happiness of mankind. That which of any two acts thus viewed, conduces the less to this happiness, it is his duty not to do; or he ought not to do, or it is wrong for him to do, or lastly is vice. So, absolutely and unconditionally, of any disposition or action which tends, on the whole, to cause unhappiness. It is generally stated, in consistency with this explanation, that conduciveness to the general happiness of mankind is the criterion of duty or virtue.

Two questions now arise, to which, before we proceed further, some sort of answer must be given. The answers to these questions will lead us to separate the science of morals from two other sciences with which it is often more or less confounded, namely, mental science, or psychology, and theology, and also to point out the relations in which it stands to these sciences. The two questions are,—what does human happiness consist of? and what renders the pursuit of human happiness man's duty?

We shall answer the second of these questions first. It is man's duty to strive to increase the general amount of human happiness, because he knows, both from the adaptation of the external world to that end, and from express revelation of God's will, that God desires the happiness of mankind. The full and detailed establishment of this proposition belongs to theology, in its two departments of natural and revealed religion. Thus is morals connected with theology. We have said that their provinces have been often more or less confounded, and this has taken place principally in two ways. God having revealed, in a general manner, the assignment of rewards and punishments in a future life to the performance of duty and its violation in this. some writers, as Paley for instance (who defines virtue as "the doing good to mankind in obedience to the will of God, and for the sake of everlasting happiness"), have directly referred virtue to an expectation of these rewards and punishments, and, instead of treating them as something extraneous and accidental, have introduced them as essentials into the definition of morality. Now morals has nothing to do with these rewards and punishments further than to determine what are the dispositions and actions to which they are respectively assigned; and this is determined altogether independently of the rewards and punishments themselves. The other way in which the provinces of morals and theology have been confounded (and here the confusion is complete) is by deriving all duty directly from the revealed will of God. Those who consult the Bible only. as being the depository of God's revealed will, for a complete enumeration of their duties, clearly reject morals as an independent science, and merge it entirely in theology. It is needless to observe that the Bible, which, as Mr. Burke observes in a well-known passage, "is not one summary of doctrines regularly digested, in which a man could not mistake his way," cannot take the place of, any more than it can be superseded by, a science which systematically treats duty on the principle of conduciveness to the general happiness of mankind.

The question, what does human happiness consist of? remains to be answered. And here too we can only generally indicate the mode of answering the question, rather than provide in detail the answer itself. Man is so framed as to be susceptible of certain pleasures and certain pains. These pleasures and pains are of two different kinds. physical and intellectual; in the last division being included the pleasures and pains of sympathy, and also those derived from the feelings of moral approbation and disapprobation. These pleasures and pains differ of course among themselves, both in kind and degree. Now generally the greater the number of pleasures gratified, and the greater the number of pains avoided, the more is man's happiness consulted; and when there is a necessity of choice between pleasures and pains of different kinds, this happiness is consulted more, in proportion as the pleasures and pains respectively gratified and avoided are more enduring and extensive in effect. The full enumeration and explanation of all the pleasures and pains of which man is by nature susceptible belongs to psychology, or mental science. Morals, availing itself of the results of this science, proceeds to determine, by a comparison, in each case, of known pleasures and pains, in respect of number and value, the different duties of man.

Much confusion has been made between mental and moral science, first by treating the moral feelings (as they are called), or the feelings of moral approbation and disapprobation, as the immediate object of moral science; and secondly, by supposing these feelings, under such names as conscience and moral sense, to be the only and all-sufficient criterion of morality or duty. The consideration of these feelings, as of all other feelings, belongs to mental science. So far as they contribute to increase the number of human pleasures and pains, their consideration is a necessary preliminary to the treatment of moral science. So far, on the other hand, as the proper direction of these feelings is concerned (which belongs to the act of education), it is clear that the enumeration and explanation of duties should precede. Those writers who, merging altogether moral in mental science, derive all duties from what they call an independent moral faculty, which, by way of making the thing clearer, they name *conscience,* or *moral sense,* or *right reason,* commit the error of mistaking the effect for the cause. So far as the judgments of this conscience, or moral sense, or right reason, are good and proper judgments, so far must they be founded upon the results of moral science, treated, as we propose to treat it, in reference to the principle of conduciveness to the happiness of mankind. And it will invariably be found that whatever of good exists in any moral system professing to be founded on something else is really (though its authors imagine otherwise) derived from this science. But where direct and conscious reference is not made to this science, there is no longer any security for the proper direction of the moral feelings. As Dr. Paley happily expresses it, "a system of morality, built upon instincts, will only find out reasons and excuses for opinions and practices already established—will seldom correct or reform either."

Thus much in the way of preliminary disquisition. We now proceed to enumerate man's several duties.

It is of course out of the question to give a complete enumeration of single separate duties, or (in other words) to state in detail all that a man ought or ought not to do under all possible varieties of circumstances. This can hardly be expected, or at any rate is seldom professed, and never accomplished, in treatises expressly devoted to the subject. The most at all events that can be done here is to name, with the addition of some brief general explanation, the chief general classes of duties. The adaptation of these general duties to particular cases is often obvious. In some cases, which will be specially noticed, the carrying out into minute detail of general rules of duty opens new and large departments of inquiry, which may be considered either as constituting separate sciences, or as belonging to other sciences rather than to morals.

In thus taking refuge in a general classification of duties, we shall have to furnish the reader with a list of *dispositions* which it is the duty of man respectively to cultivate and not to cultivate. A disposition is a tendency in a man to act (under which word is comprehended thinking, feeling, speaking, and doing) generally in a certain way. The names for the different dispositions thus come to embrace general classes of actions. For instance, the disposition called *benevolence* leads to innumerable actions which, under innumerably different circumstances, it is man's duty to perform; and the name therefore stands as a general name for all these actions. To name singly and separately all these actions would perhaps not be practicable, and is certainly not desirable. Certain sub-classes of them may be named, in explaining the beneficial tendency of the general disposition, or (in other words) the reasons why it is man's duty to cultivate this disposition. This last explanation will necessarily comprehend a general view of the advantages of the different actions which the disposition tends to produce.

There are many different principles of classification on which the enumeration of duties may proceed. It is perhaps not too much to say that all duties may be deduced, with a greater or less exercise of ingenuity, as corollaries from any one which has been previously established. Thus Wollaston, in his 'Religion of Nature,' deduces all man's duties from the duty of truth. Hobbes again, in his 'De Cive,' derives all morality from the duty of preserving peace. It is clear that the mode to be adopted of treating the subject, or, in other words, the mode of classifying our enumeration of duties, is a matter entirely of convenience; and, merely as a matter of convenience, we shall adopt the division of duties which has been partly acted upon by Dr. Paley, and which is perhaps the division most generally resorted to by writers on morals.

We shall treat of a man's duties, first, as they regard himself individually, and, secondly, as they regard others. It is necessary to remark, in order to prevent misapprehension, that one duty is a duty towards oneself, and another duty is a duty towards others, not on account of its tending respectively to produce happiness only to oneself or only to others, but simply from the accidental circumstance of oneself in the one case and others in the other being, as it were, the outward object of the action or disposition which constitutes the duty. "Those acts of ours," to quote from Mr. James Mill, "which are primarily useful to ourselves, are secondarily useful to others; and those which are primarily useful to others are secondarily useful to ourselves." ('Analysis of the Human Mind,' vol. ii., p. 284.) Much of the good resulting from the performance of what we call duties towards ourselves consists in our being thereby better enabled to do good to others; and together with the happiness conferred on others by the performance of our duties towards them, is the happiness caused to ourselves by the gratification of our feelings of sympathy and of duty, and the additional security that is gained for the good-will of others towards ourselves.

I. A man's duty to himself consists generally in the preservation of the life with which his Creator has endowed him, and in the improvement, to the greatest degree in his power, of the faculties which he possesses.

The first part of this duty is altogether negative. A man must abstain from wantonly exposing himself to danger, or, in other words, he must be *prudent*, and he must refrain from *suicide*. For when man learns that God has adapted his created world to the production of general happiness, he learns at the same time that life has been given for that purpose; and in foolishly risking or in laying violent hands upon his own life, he tends so far to mar God's object. He throws away his own means of attaining happiness in the way in which God has willed that he should attain it, and he destroys also his means of promoting the happiness of others.

As regards the second part of a man's duty towards himself, consisting in the improvement of his faculties, or, as we may otherwise express it, of his intellectual and moral being, this is partly positive and partly negative. It is a man's duty to improve himself, so far as he can, by study and by cultivating good dispositions; the full explanation of the best mode of doing which belongs properly to the subject of education. It is his duty also not to deteriorate his character by sensual excesses. The vices which he has thus to guard against are principally two, *lust* and *intemperance;* the latter of which divides itself into *drunkenness* and *gluttony*. The names of the two virtues opposite to the two vices of lust and intemperance are *chastity* and *temperance*. The cultivation of these two virtues, or the abstinence from the two corresponding vices, is recommended not only by the good accruing to the individual, but also by the extent to which he is thereby saved from inflicting injury on others.

II. In considering a man's duties towards others, we would adopt the subdivision of duties towards men generally as men, and duties towards men as members of the same society. These last duties will be again subdivided into duties towards members of the same political society or state, and duties towards members of the same family.

1. The duties towards men generally as men, or towards mankind, may be comprehended under the general names of *benevolence* or *kindness*, *courage*, *sincerity*, and *humility*.

In benevolence or kindness are included *sympathy*, or a general disposition to assist our fellow-men; *pity*, or kindness towards those in distress, and towards inferiors; *generosity* or *liberality*, which, being the disposition to make our own means serviceable to others, turns pity to good account; *gratitude;* and *charity*, in the sense in which it is used by St. Paul, or the disposition to judge kindly of others' conduct. The vices opposed to sympathy, pity, generosity, gratitude, and charity, are *selfishness*, *hardheartedness* or *cruelty*, *avarice*, *ingratitude*, and *malevolence* or *uncharitableness*. *Slander* is one principal form in which the last-mentioned evil disposition displays itself. The cultivation of the virtues comprehended under the name *benevolence*, and the avoidance of the opposite vices, have an obvious and immediate bearing on the happiness of others. At the same time it is not to be forgotten that happiness accrues to the benevolent man himself from the gratification of his natural feelings of sympathy, and that by doing good to others he disposes others to do good to him.

Courage is valuable, as tending to give effect to our benevolence. It must not exist in such excess as to lead a man to adventure a great risk for a disproportionately small object, and must therefore be governed by prudence. Mr. Mill indeed has treated of courage as a particular form of prudence, a mode of treating of it which we cannot think proper. There is an obvious difference, which Mr. Mill seems strangely to have lost sight of, between courage being governed by prudence, as it unquestionably ought to be, and courage being only a particular form of prudence.

Sincerity comprehends *truth* in words and *honesty* or *justice* in conduct. The manner in which the practice of these virtues, or the abstinence from the opposite vices of *lying* and *cheating*, is recommended by general utility, is obvious. Without the general observance of truth and honesty, men would have no confidence in one another, and there would be no safety. The proverb, that "honesty is the best policy," pithily expresses the bearing of this virtue on one's own good. Kant, in his 'Metaphysic of Ethics' (*Metaphysik der Sitten*), classes the virtue of sincerity among the duties owed by a man to himself. "A lie is the abandonment and, as it were, the annihilation of the dignity of a man."

It remains to speak of *humility*. This is perhaps not so decidedly a virtue as its opposite, *pride*, is a vice. The evil of this vice consists in its tendency to hurt the feelings of others, and to diminish our disposition to do good. Tolerance of others' opinions, and reverence towards superiors in intellectual and moral worth, are forms of humility; and these are dispositions which, when they exist, are fruitful of much good both for oneself and for others.

2. The duties towards men as members of the same political society or state, resolve themselves into the general dispositions of *patriotism* and *obedience*. The first is a virtue, the value of which has been often greatly overrated, and which is very apt to degenerate into the failing called *nationality*. But nevertheless it is a virtue. As the general happiness is best pursued by each individual making his own happiness his own chief object, and again by each body of individuals making the pursuit of their own separate interests their chief object, patriotism properly tempered, or the desire to benefit one's own country so long as this is not done in such manner as to injure other countries, is one valuable means of promoting the general happiness of mankind. Of obedience to those who are invested with authority in a state, and to the laws, it belongs to morals to speak only in the most general manner. The filling up of the detail belongs to political science. This science having determined what laws ought to be enacted, on the ground of conduciveness to general happiness, morals enjoins obedience to them, without reference to their individual goodness, but for the sake of maintaining political society generally, and of preserving to men all the advantages which political society yields.

3. The duties towards others who are members of the same family consist altogether in affection, which manifests itself differently according to the different family relations. Thus we speak of conjugal affection, paternal and maternal affection, filial affection, and fraternal affection. Conjugal affection implies fidelity. The proper exercise of the paternal and maternal affection opens a wide field of discussion; but it may be said generally to show itself best in the proper education of the children. Into filial affection gratitude and reverence largely enter. Fraternal affection differs from friendship only in the peculiar relation under which the feeling exists.

Thus have we given a brief general summary of man's duties. We have said nothing of duties towards God, which are generally made to form a separate division in treatises on morals, because we conceive that these duties, so far as they depend on God's special commands, and thus differ from the duties which we have enumerated, and which we come to know by observing their tendency to promote general happiness, belong to the separate subject of religion; in the same way as the duties which depend on positive laws enacted in a political society have been referred to political science. Generally we may say that man ought to entertain feelings of reverence and gratitude to God, by reason of his superiority, and of the blessings which he has conferred upon us. But the duty of entertaining these feelings in this particular case flows at once from the general duties of gratitude to a benefactor and reverence towards a superior; and inasmuch as the application of the general duties to this particular case needs not the assistance of revelation, and involves no essential difference from the application to other cases, there seems no necessity for a separate division.

So also the duty of kindness to the inferior animals must be taken as a corollary from the general duty of kindness which has been inculcated. The pain which we believe that God wills shall not be inflicted upon men, we must believe too that he wills shall not be inflicted on other animals which he has created. The pain of which animals are susceptible we suppose to be of the same sort as that of which men are susceptible; at least we have no means of conceiving any other sort of pain. And inasmuch as no different circumstances are introduced, there is no need for a separate division wherein to treat of our duties towards the inferior animals.

MORASS. [Marshes.]

MORAVIANS, or MORAVIAN BRETHREN, a congregation of Christians descended from the Bohemian brethren, who were a branch of the Hussites. [Huss, John, in Biog. Div.] The Bohemian brethren dissented from the Callixtines, and refused to subscribe to the articles of agreement between that party and the council of Basel in 1433. They then formed themselves into a distinct community, called "the Brothers' Union," and as they were obliged to live in seclusion through fear of persecution, they were called by their enemies "Grübenheimer" or Troglodytes. They looked upon the Scriptures as their rule of faith, rejected transubstantiation, and were very strict in their discipline, excluding the vicious, the scoffers, and the worldly from their communion. They established among themselves a superintendence over the practical and domestic conduct of individuals, who were distributed into three classes, the beginners, the proficient, and the perfect. They had their bishops, seniors, presbyters, and deacons, who administered their civil as well as ecclesiastical affairs. Like the Quakers they refused to do military service.

When the great Reformation took place in Germany, the Bohemian brethren sent envoys to Luther in 1522, who approved of most of their doctrines and discipline, and although he did not admit every article of their confession of faith, yet he said that it might be tolerated as it was. (Mosheim, 'Ecclesiastical History,' xvi. cent., iii. 2.)

In 1547 most of the brethren were expelled from Bohemia by Ferdinand I., upon which they took refuge in Poland and Prussia, where they formed several settlements, especially at Marienwerder. They were united for a time with the Lutherans by the convention of Sendomir, but afterwards drew closer to the Calvinists at the synods of Ostrorog in 1620 and 1627, and adopted Calvin's creed, retaining their own Bohemian forms of discipline. (Elsner, 'Brevis Conspectus Doctrinæ Fratrum Bohemorum,' in Gerdes's 'Miscellanea Groningiana,' vol. vi.)

Under Maximilian II., those brethren who had remained in Bohemia and Moravia enjoyed full toleration, and they formed their chief settlement at Fulnek in Moravia, whence they received the name of Moravian brethren. But in the subsequent Thirty Years' war, their settlements in Bohemia and Moravia were utterly destroyed, and, after various migrations, their descendants were settled, in 1722, by Count Zinzendorf, on his estate of Bethelsdorf in Upper Lusatia, where their colony took the name of Herrnhut, from a hill in the vicinity called Hutsberg. [Zinzendorf, in Biog. Div.] They then established themselves as a new community under the name of the United Brethren, to which Protestants of every denomination were admitted, without being obliged to renounce their respective creeds, but on condition of conforming to their rules of discipline, which were derived from those of the Bohemian brethren. Since that time the community of the United or Moravian brethren has greatly increased, and has spread through Germany, Holland, the United States, and other Protestant countries. Wherever they have formed a new and distinct settlement, they have enforced their regulations of civil and religious discipline upon all the members of the community, but there are many Moravians scattered about in towns among people of different communions, where they form small congregations and have their own meetings. The Moravians do not assume to constitute a separate sect, and whenever they have been required as a body to state their creed, they have professed a general adherence to the confession of Augsburg, and their preachers, without pledging themselves to all its articles, reject any doctrine which is repugnant to it. They avoid discussions on the speculative truths of religion; they acknowledge the manifestation of God in Christ, and consider the life, sufferings, death, and merits of the Saviour as the foundation of their faith. They look upon the Scriptures as the revelation of God. They also believe that the Spirit of God continues to enlighten inwardly those who pray for it for the purpose of regulating their conduct, and they make a practice of invoking it in circumstances of doubt and uncertainty, before coming to a determination. Each community, represented by its elders, presbyters, and deacons, provides for the spiritual wants of its members, for its churches, schools, hospitals, and other public establishments, and the funds for these objects are raised partly by subscriptions and partly by rates levied on the householders. In other respects every family in the community carries on its private affairs, and manages its own interests and property as in other communities. The erroneous notion of their having community of goods arose from the circumstance that some of their first settlers in North America, being few and forlorn among strangers, found it convenient for a time to put their earnings into a common stock.

One of the principal objects of the Moravian institution which they pursued at a very early period, was to send out missionaries among the heathen. Their mission to Greenland has been celebrated by James Montgomery, and they have furnished missionaries for the Caffres and Betchouanas in South Africa, for the Delaware Indians and the Cherokees in North America, for the Esquimaux of Labrador, and for the negroes of the West Indies.

The Moravians, like the Quakers, reject gaudiness and ornament. Promiscuous assemblages of the two sexes are forbidden among them, as well as plays, games, and dancing. They have however church music and singing. The unmarried men live together in a separate building called the house of single brethren, under the superintendence of an elder; and there are likewise houses for single sisters and widows. Marriages among members of the society must be sanctioned by the elders. They wear no mourning for the dead, looking upon death as a happy release from earthly bonds: their expression on such an event is, that the deceased is gone home to the Lord.

MORDANTS. [Dyeing.]

MORIC ACID. [Tannic Acids.]

MORIN. [Tannic Acids.]

MORINDIN ($C_{28}H_{15}O_{15}$). A non-azotised colouring principle, found in the root of the *Morinda citrifolia*. By the action of heat it yields *morindone* ($C_{28}H_{10}O_{10}$). M. Rochleder believes that morindin is identical with ruberythric acid, and morindone with alizarin. [Madder, Colouring matters of.]

MORINDONE. [Morindin.]

MORINGIC ACID. [Ben, oil of.]

MORINTANNIC ACID. [Tannic Acids.]

MOROXYLIC ACID. [Tannic Acids.]

MORPHIA. [Opium, Alkaloids of.]

MORPHINE. [Opium, Alkaloids of.]

MORRIS DANCE. Douce, in a dissertation on the ancient English Morris Dance at the end of the second volume of his 'Illustrations of Shakspeare,' affirms that both English and foreign glossaries uniformly ascribe the origin of this dance to the Moors; although the genuine Moorish or Morisco dance was, no doubt, very different from the European Morris. Strutt, in his 'Sports and Pastimes of the People of England,' has cited a passage from the play of 'Variety,' 1649, in which the Spanish Morisco is mentioned as being danced by one person only, and he thinks the origin of the term might be found at home. Mr. Douce, however, maintains that this not only shows the legitimacy of the term Morris, but that the real and uncorrupted Moorish dance was to be found in Spain, where it still continues to delight both natives and foreigners under the name of the fandango.

It has been supposed that the Morris dance was first brought to England in the time of Edward III., when John of Gaunt returned from Spain; but it is more probable that we had it from our Gallic neighbours, or even from the Flemings. Few, if any, vestiges of it can be traced before the reign of Henry VII., about which time, and particularly in that of Henry VIII., the churchwardens' accounts of numerous parishes show that the Morris dance made a considerable figure at parochial festivals.

The hobby-horse, which once performed the principal character in the dance, was a light frame of wicker-work, furnished with a pasteboard head and neck of a horse. This was buckled round the waist, and covered with a foot-cloth which reached on the ground, and concealed at once the legs of the performer and his gingling apparatus. Thus equipped, he pranced and curvetted in all directions, neighing, and exhibiting specimens of boisterous and burlesque horsemanship. Besides the hobby-horse, there were, the fool or buffoon of the party; May or Maid Marian, and her paramour a friar; a serving-man, a piper, and two Moriscoes. The dress of these personages is described by Fletcher in his 'Women Pleased,' when he says:—

> "Where are your bells then,
> Your rings, your ribbands, friend, and your clean napkins,
> Your nosegay in your hat, pinn'd up?" &c.

Gifford, in his edition of Ben Jonson's works, remarks, "When the right good-will with which these persons capered is taken into consideration, the clean napkin, which was never omitted, will not appear the least necessary part of the aparatus." Thus Clod, in the masque of 'The Gipsies,' observes, "They would be Morris dancers by their gingle, but they have no napkins." Maid Marian was the lady or queen of the May.

MORTALITY, BILLS OF. [Bills of Mortality.]

MORTALITY, LAW OF. In this article we intend to confine ourselves to some account of our present knowledge, theoretical and practical, of the laws which are found to regulate mortality among mankind in this country.

Uncertain as is the life of any one individual, it is now very well known that if two different numbers of individuals, at or near the same age, be taken, the number that will be left at the end of a few years will be nearly the same, if they exist during that time under similar circumstances. No tables, however different the station and circumstances of the person from whose lives they are made, differ from one another by anything like the amount which might be supposed likely by one who turns his thoughts rather to the existence of one individual than of a large number. A little consideration will make the probability of something like permanence in the distribution of mortality very great *à priori*. That harvests fluctuate in goodness is very well known; but it is also obvious that if the fluctuations upon a whole country had been as great as those upon an individual field, the human race must long ere this have been starved off the face of the earth. If, in the same manner, the mortality of races had varied as much as that of families, it is impossible that the population of any country could have gone on in a gradual and regulated state of increase; or supposing that large fluctuations had compensated each other, the consequence must have been such a disproportion of the numbers living at different ages as it never has occurred to any one to imagine possible.

The law of mortality, theoretically speaking, is a mathematical relation between the numbers living at different ages: so that, having given a large number of persons alive at one age, it can be deduced by the law what number shall survive any given number of years: practically speaking, it is, in the absence of such a mathematical law, the exhibition in a table of the numbers surviving at the end of each year. Thus, DE MOIVRE'S HYPOTHESIS (namely, the supposition that out of 86 persons born one dies every year till all are extinct) is an asserted theoretical law of mortality; while the Carlisle table, presently given, is a practical one.

If y represent the number of persons living at the age of x, out of a certain number a at a certain previous age (usually the time of birth), then if a line varying with x be made the abscissa of a curve, and another varying with y its ordinate, this curve may be called the curve of mortality. Its form, as deduced from a given set of observations, may lead, by comparison with known curves, to an equation which, more or less accurately, connects y and x.

Besides De Moivre's hypothesis, others have been given, the principal of which we shall notice in order.

A curve following a mathematical law may be drawn through any points, however great their number or irregular their distribution; but the greater the number of points, the more complex will be the equation of the curve. With an equation of a high degree (the tenth, perhaps, or the twelfth), any given table of mortality might be very nearly represented; but such complexity would be useless, and it has therefore never been attempted. Similarly, by using arcs of different curves, a near representation might be attained; but such a method, being practicable in many different ways, would not possess the interest attaching to one simple and uniform law, and would only attract attention by offering facilities for the actual calculation of life-contingencies.

In 1765 Lambert presented an equation of the following form, as representing very closely the London table (ϵ is the base of Napier's logarithms):—

$$y = 10000\left(\frac{96-x}{96}\right)^2 - 6176\left\{\epsilon^{-\alpha x} - \epsilon^{-\beta x}\right\}$$

α being $= 1 : 13{\cdot}682$, and $\beta = 1 : 2{\cdot}43114$, and y being the number surviving at the age of x, out of 10,000 born. This form, if it could be made to represent other tables, by an alteration in the constants, would be one of great practical utility; but we are not aware of any attempt having been made to extend it.

Mr. Benjamin Gompertz, in 1825, presented to the Royal Society a memoir 'On the Nature of the Function expressive of the Law of Human Mortality.' As this ingenious paper contains a deduction from a principle of high probability, and terminates in a conclusion which accords in a great degree with observed facts, it must always be considered as a very remarkable page in the history of the inquiry before us. We enter into some detail of it the more readily, that it is necessary as an act of justice to Mr. Gompertz, whose ideas have been adopted by a writer on the subject, in a work published in 1832, without anything approaching to a sufficient acknowledgment. (See on this point the 'Journal of the Institute of Actuaries,' vol. ix., part 2, July, 1860.)

There is in the human constitution a power of resisting the effects of disease, which increases from birth up to a certain age, and diminishes from that time forwards; the evidence of such diminution being the increased proportion of deaths in a given time. The proportion is found, in most tables, not to be altered by equal quantities in equal times, but to diminish in a greater ratio as life goes on. Mr. Gompertz assumes that the "power to oppose destruction" loses equal proportions * in equal times; so that the intensity of mortality, supposed inversely proportional to this power, must be represented by the formula $a\,q^x$, where a is its value at the commencing age from which x years are reckoned, and q a constant depending on the rate of increase of the intensity. If, therefore, y be the number living at the end of x years, $y\,.\,a\,q^x\,d\,x \times b$ is the decrement of that number in the time $d\,x$, where b is another constant; and this gives $d\,y = -\,a\,b\,q^x\,y\,d\,x$, which integrated is of the form

$$y = l\,g^{(q^x)}$$

where q, l, and g are to be determined. This can be done by three values of y out of the given table; and the result, hitherto purely hypothetical, can then be compared with the other parts of the table, by calculation of the values of the formula for different ages. The more convenient form of the above is

$$\log y = \log l \pm \text{no. wh. log. is } (\text{log. } \log g + x \log q)$$

where $\log\log g$ is taken without reference to the sign of $\log g$, and the upper or lower sign is used according as g is greater or less than unity.

Among other comparisons, Mr. Gompertz has made one with the Carlisle table from the age of 10 to that of 60, and another (deducing different values of l, g, and q) from 60 to 100. The two formulæ obtained are, using $\log^{-1}$ for the phrase "no. whose logarithm is," and x meaning the age of the parties,

$$\log y = 3{\cdot}88631 - \log^{-1}\left\{2{\cdot}75526 + {\cdot}0126\ \ x\right\}$$

$$\log y = 3{\cdot}79657 - \log^{-1}\left\{\bar{3}{\cdot}74767 + {\cdot}02706\,x\right\}$$

In the first set of ages the discordance between the formula and the table is only in one instance as great as half a year; that is, there is only one instance in which the number deduced from the formula as alive at a given age represents the number living in the table at an age so distant from the given age as half a year. Several other comparisons, with other tables and different constants, give equally satisfactory results. Few who know the best tables of mortality will be inclined to think that their probable error is within half a year; so that, as we now stand, Mr. Gompertz's principle, namely, "that equal proportions of the 'power to oppose destruction' are lost in successive small equal times," is as well established for a large portion of life as any of the tables. It is remarkable that the approximate accuracy of the common method of finding an annuity on three joint lives, by substituting for *two* of the lives *one* life of the same value, is a consequence of the approximate truth of Gompertz's law. (See the 'Assurance Magazine,' July, 1859, vol. viii. p. 4.)

We now come to the practical exhibition of the law of mortality in tables. A very good account of the history of the subject, by Mr. Milne, appears in the 'Encyclopædia Britannica' article 'Mortality,' the references in which may be consulted by those who desire information on the state of the question in foreign countries. We shall in this article confine ourselves principally to English tables.

The obvious and simple mode of forming a table of mortality would be to take a large number of infants born alive, all of the same sex and in the same station of life. If the numbers left alive at the end of every year were noted, until all had become extinct, a column of ages, accompanied by an opposite column noting the number of survivors, would be a table of mortality in the most usual form. Such a table might be called a table of decrements. Let l_0 represent the number born, and l_x the number who survive to the age of x.

The formation of such a table might require a century of observation. To avoid this, the law of mortality must be assumed stationary; that is, it must be presumed that, out of those who reach, say age 70, the proportion who die in a year is now what it will be when an infant new-born reaches that age. This being assumed, let the members of a community be counted, and their ages registered; at the end of a year it will appear what proportion of each age has died. If the process be repeated in succeeding years, other sets of events are obtained, which may all be put together into one table, when the number has become large enough to secure the observed events representing the average, and to destroy the effects of accidental fluctuations. If then altogether k_x persons have attained the age x, of whom k_{x+1} have survived to the age $x+1$, it follows that the proportion who die in a year is $(k_x - k_{x+1}) : k_x$, which may be represented by m_x. A table of the values of m_x might be called a table of the yearly rates of mortality.

A table of yearly rates may be converted into a table of decrements, as follows. Assume a number l_0 to be born, then from the table of yearly rates,

$$l_1 = (1 - m_0)\,l_0,\ l_2 = (1 - m_1)\,l_1,\ \text{\&c.}$$

If the population, say of a town, remained unaffected, or sensibly unaffected by immigration or emigration, that is, if all who were born in the place, and no others, were registered in the burials of the place, the burial registers would form a mortality-table, provided the rate of increase of the population were steady and known. For, firstly, if the population had remained stationary for a long time preceding the commencement of registration, the yearly deaths and births being equal, and if the mortality had also remained stationary, the burials of any one year, the parties being distributed according to age, would show the law of mortality as follows:—Suppose the registers of a year showed that M_0 died in their first year, M_1 in their second year, and so on, the equality of births and deaths shows that $M_0 + M_1 + M_2 + \dots$ must have been born in that year, and the stationary character of the law of mortality being assumed, it follows that of $M_0 + M_1 + \dots$ persons born, it is the law of the mortality that M_0 die in their first year, or that $M_1 + M_2 + \dots$ survive; similarly that $M_2 + M_3 + \dots$ survive two years, and so on. But if the population be in a state of increase, and if the annual ratio of increase be that of $1 : 1 + \mu$, those who die at the age $x - 1$ and x cannot be incorporated in the same table, since the first are a portion of a table beginning with a larger nnmber of births. The former then must be reduced, or the latter increased, in the proportion of $1 : 1 + \mu$: so that if M_0, M_1, &c., be the deaths in the first, second, &c. years of age by the register, the table must run thus: of

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* The word in the eighth page of the memoir cited is *portions*, which is a misprint or an oversight, as the formula immediately following shows. If x be the time, $a - b\,x$ loses equal portions in equal times, and $a\,.\,b^{-x}$ equal *proportions*.

$$M_0 + M_1 (1 + \mu) + M_2 (1 + \mu)^2 + \dots.$$

persons born, M_0 die in their first year, $M_1 (1 + \mu)$ in their second, and so on.

A table of mortality may also be given in the form of a table of the mean durations of life, calculated as in LIFE, MEAN DURATION OF. Or the table of mean durations may be calculated from the table of yearly rates, as follows:—Let e_n be the mean duration of the lives aged n, and m_n the yearly rate at the same age: then

$$e_n - \tfrac{1}{2} = (1 - m_n)\,(e_{n+1} + \tfrac{1}{2})$$

by which, beginning from the end of life, the mean duration at each age may be computed from that at the age next higher.

Various tables of these several kinds have been constructed, beginning with that made by Halley from the town of Breslau, and ending with that formed by the Equitable Insurance Office from its own materials, and with the Actuaries' Table presently mentioned. If we were to look to the wants of the subject, whether as a physical investigation or a statistical one, we should find that it is everywhere in the merest infancy. The fact of a difference of mortality between the two sexes is established, and it also seems to be known that where the occupations of females are not above their strength, their mortality is less than that of males; but no settled determination of the amount of difference has been obtained. As to whether married or single life is the longest, whether the age of the parents, or the relative age, affects the mortality of the children, whether the earlier children of a marriage differ in their law of mortality from the later, &c., we have no trustworthy information at all. In some foreign countries, as in Sweden and Belgium, the attention paid by the government to statistical subjects has produced some results which are worth a good deal; the reader may consult the article in the 'Encyclopædia Britannica,' already cited, for reference to them. We shall now give merely the dates and titles of the most remarkable earlier tables connected with the subject.

1538. Parish registers first kept in England.

1540–41. The statute 32 Henry VIII., c. 28, enabling ecclesiastical persons and corporations to grant leases for *three lives*, or *twenty-one years*. From this permission springs, we think, much of the attention which has been paid to the subject of life leases in England. It gave rise to certain tables of the value of leases which were called 'Æcroid's Tables,' and which were put together, as was thought by later writers, about the end of the reign of Henry VIII. They assume a rate of interest greater than 11 per cent. After the Restoration, when the interest of money had very much fallen, the ecclesiastical lessors began to raise their fines. This occasioned great dissatisfaction, and frequent representations to the House of Commons, which, though it passed no law, in several cases recommended to particular bishops, &c., an adherence to the old rule. Attention began to be turned towards the actual value of life. In 1662 John Graunt published his 'Natural and Political Observations on the Bills of Mortality,' often reprinted. In 1674, Sir William Petty, in a paper in the 'Philosophical Transactions,' proposed a law of mortality of the following kind: the probability of one life surviving another, after the age of 16, is inversely as the square roots of the ages. In 1685 were published the well known 'Tables for renewing and purchasing the leases of Cathedral Churches and Colleges,' the methods of which were certified to be correct by Newton, and which therefore have been frequently called Newton's Tables. About 1720, if not before, a letter called 'The Value of Church and College Leases considered,' was appended to these tables, and a very sharp controversy took place, which produced a great many pamphlets; the party of the lessees appealing to custom, the lessors showing from the value of life and interest of money that the church landlord dealt more leniently with his tenant than the layman, as was indeed the case. Among the writings which arose out of this controversy was 'The Gentleman's Steward instructed,' 1730, by John Richards, containing the most complete tables of annuities which had been published.

The work of Graunt and the political essays of Sir William Petty preceded, and probably stimulated the attempt of Halley to construct (in 1692) a table from the bills of mortality at Breslau, which was published in 1693. In 1699 came Dr. Davenant's 'Essay,' &c., containing extracts from some tables by Gregory King (afterwards published entire), which Mr. Milne states to represent tables since made with great accuracy. Kerseboom's tables of lives (constructed from Dutch registers of annuitants) appeared in 1738, 1740, and 1742. De Moivre's 'Treatise on Annuities,' containing his celebrated hypothesis, was published in 1724; and Thomas Simpson's work on the same subject, containing a table deduced from London observations, in 1742. Deparcieux, in 1746, published his 'Treatise on Annuities,' containing his tables deduced from the lives of French annuitants, as well as from monks and nuns. These were the first tables in which male and female life were distinguished from each other.

The works of Price, Baily, Milne, &c., contain altogether a large number of tables, which we shall here no further notice than to give references to the works in which they may be found, with other matters connected with the same subject.

'Observations on Reversionary Payments,' by Richard Price, D.D., seventh edition, edited by William Morgan, London, Cadell and Davies, 1812.

'The Doctrine of Annuities and Assurances,' by Francis Baily, London, Richardson, 1816. This work, now out of print, has been translated into French, under the title 'Théorie des Annuités Viagères,' traduit de l'Anglais per Alfred de Courcy, Paris, Bachelier, 1836. There is also a spurious edition, issued ten or twelve years ago, which is an imitation of the type, &c., of the original.

'A Treatise on the Valuation of Annuities and Assurances,' by Joshua Milne, London, Longman & Co., 1815.

'On the Natural and Mathematical Laws concerning Population, Vitality, and Mortality,' by Francis Corbaux, London, 1833. This work contains a large number of tables.

Reports (two in number) of Select Committees of the House of Commons on the Laws respecting Friendly Societies. Ordered to be printed, July 5, 1825, and June 29, 1827.

'Report of John Finlaison, actuary of the national debt, on the evidence and elementary facts on which the tables of life annuities are founded.' Ordered by the House of Commons to be printed, March 31, 1829.

'Library of Useful Knowledge,' treatise 'On Probability.' This anonymous work is by Sir John Lubbock and Mr. Drinkwater (Bethune), but by some mistake many copies were issued with Mr. De Morgan's name on the binding.

'Treatise on Friendly Societies,' by Charles Ansell, &c., London, Baldwin & Cradock, 1835.

'Tables showing the total number of persons insured in the Equitable Society from 1762 to 1829,' &c., by Arthur Morgan, London, 1834.

Mr. Rickman's various Reports on the Population Census contain tables deduced from them.

'Recherches sur la Reproduction et la Mortalité,' &c., par MM. Quetelet et Smits, Bruxelles, 1832; and 'Sur l'Homme, &c., ou Essai de Physique Sociale,' 2 vols., par A. Quetelet, Paris, Bachelier, 1835. These works exhibit for Belgium what we could wish to see imitated in England.

'Tables of Mortality, deduced from the experience of the Amicable Society during 38 years, ending 1841.' Published in 1841.

'Law of Mortality, deduced from the combined experience of 17 offices, embracing 83,905 policies, of which 40,616 are distinguished by denoting the sex of the lives assured, and by classing them into town, country, and Irish assurances.' Privately printed for the offices in 1843. This table was constructed on *policies*, not on *lives*: a person insured in two or more of the seventeen offices counted as two or more persons, all of whom were bound to die at the same moment. Perhaps this would make little difference in the general results, though it would be unsafe to assume as much. Again, though seventeen offices were combined, yet the Equitable and the Amicable put together make up far the largest part of the whole. The distinctions pointed out between male and female life (that is, *assured life*), are no doubt correct, and are very remarkable. Female life, though better than male life, appears worse among assured females than among assured males. But the *female* difference and the *Irish* difference are probably to be explained by reasons which more concern the offices than the student of the physical law of mortality.

The publications of the registrar-general commenced in 1839. It would be impossible to give any account of this valuable and ever growing mass of materials in any space which we could afford. And there would be little satisfaction to the reader of a few years hence in the perusal of what he would know must be then very imperfect. We hope that the registrar-general himself will soon feel it his duty to give the public a digest of results, with the proper references, and a complete list of his publications. And when, speaking with due official propriety, we mention the registrar-general, all who are conversant with the subject will know that we mean Dr. Farr, who is as much the guiding spirit of the Registry Office as Sir Rowland Hill is of the Post Office.

We shall now proceed to give some tables of mortality, namely, the Northampton and Carlisle tables, those of the Equitable Insurance Office, and Mr. Ansell's Friendly Societies' table. We shall give a brief description of each.

1. Northampton Table. This table was formed by Dr. Price from the burial registers at Northampton, between 1741 and 1780. He has not distinctly described the process by which he formed it. This table was for a long time the only one used by the insurance offices. It is

now known to give the probabilities of life too low at the younger and middle ages. Some of this (but probably not all) is due to the increased value of life in England since the middle of the last century. This table contains both males and females in nearly equal numbers. The accordance of the Northampton Table with De Moivre's Hypothesis at the middle ages of life is remarkably close. (Price, 'Obs. on Rev. Paym.,' vol. ii., p. 94.)

2. The Carlisle Table. The materials of this table were obtained by Mr. Milne from a tract published by Dr. Heysham of Carlisle, in 1797, containing the bills of mortality from 1779 to 1787, both inclusive. The proportion is ten females to nine males. From the verifications which this table has since received, it must be considered as the most correct representative of healthy life in England which exists. (Milne, 'On Annuities,' p. 404.)

3. The Equitable Table. The tract in which this is found is cited above. It represents the experience of the Equitable Society from 1760 to 1829, and agrees closely at the middle ages with the Carlisle table. The agreement would be a little closer in most parts but for the following circumstance. In the formation of this table it is presumed that all those who discontinued their insurance lived, one with another, one-half of their year of discontinuance in the society. Now (throwing aside short insurances, which are always very small in number) the modes of discontinuance are only abandonment by neglect to renew the premium, and sale to the society. In the former case the parties live the whole year of discontinuance in the society, since their intention not to renew would be no bar to a claim on the part of their executors if their death took place during a year at the beginning of which premium had been paid; and it is well known that in the earlier history of every insurance office, abandonments were much more frequent than sales. And even in the case of sales to the office, it may reasonably be assumed, unless proof to the contrary were shown, that they take place, for the most part, shortly before a new premium becomes due, parties frequently choosing to take the benefit of the insurance as long as they can, and to sell when a new payment is

I. Decrements of Human Life, according to the Northampton, Carlisle, Equitable, and Friendly Societies' Tables.

Age.	Northampton.	Decrements.	Carlisle.	Decrements.	Equitable.	Decrements.	Friendly Societies.	Decrements.	Age.
0	1650	3000	10000	1539	..				0
1	8650	1367	8461	682	..				1
2	7283	502	7779	505	..				2
3	6781	335	7274	276	..				3
4	6446	197	6998	201	..				4
5	6249	184	6797	121	..				5
6	6065	140	6676	82	..				6
7	5925	110	6594	58	..				7
8	5815	80	6536	43	..				8
9	5735	60	6493	33	..				9
10	5675	52	6460	29	5000	36			10
11	5623	50	6431	31	4964	36			11
12	5573	50	6400	32	4928	36			12
13	5523	50	6368	33	4892	36	8669	52	13
14	5473	50	6335	35	4856	36	8617	54	14
15	5423	50	6300	39	4820	36	8563	56	15
16	5373	53	6261	42	4784	36	8507	58	16
17	5320	58	6219	43	4748	36	8449	60	17
18	5262	63	6176	43	4712	36	8389	62	18
19	5199	67	6133	43	4676	35	8327	64	19
20	5132	72	6090	43	4641	34	8263	66	20
21	5060	75	6047	42	4607	33	8197	68	21
22	4985	75	6005	42	4574	33	8129	70	22
23	4910	75	5963	42	4541	33	8059	71	23
24	4835	75	5921	42	4508	33	7988	73	24
25	4760	75	5879	43	4475	34	7915	75	25
26	4685	75	5836	43	4441	34	7840	77	26
27	4610	75	5793	45	4407	34	7763	79	27
28	4535	75	5748	50	4373	34	7684	81	28
29	4460	75	5698	56	4339	34	7603	83	29
30	4385	75	5642	57	4305	35	7520	85	30
31	4310	75	5585	57	4270	35	7435	87	31
32	4235	75	5528	56	4235	36	7348	89	32
33	4160	75	5472	55	4199	37	7259	91	33
34	4085	75	5417	55	4162	38	7168	93	34
35	4010	75	5362	55	4124	38	7075	95	35
36	3935	75	5307	56	4086	39	6980	98	36
37	3860	75	5251	57	4047	40	6882	100	37
38	3785	75	5194	58	4007	42	6782	102	38
39	3710	75	5136	61	3965	43	6680	105	39
40	3635	76	5075	66	3922	43	6575	107	40
41	3559	77	5009	69	3879	44	6468	109	41
42	3482	78	4940	71	3835	44	6359	111	42
43	3404	78	4869	71	3791	44	6248	113	43
44	3326	78	4798	71	3747	45	6135	115	44
45	3248	78	4727	70	3702	47	6020	117	45
46	3170	78	4657	69	3655	47	5903	118	46
47	3092	78	4588	67	3608	48	5785	120	47
48	3014	78	4521	63	3560	49	5665	122	48
49	2936	79	4458	61	3511	50	5543	124	49
50	2857	81	4397	59	3461	52	5419	126	50
51	2776	82	4338	62	3409	55	5293	129	51
52	2694	82	4276	65	3354	58	5164	131	52
53	2612	82	4211	68	3296	62	5033	134	53
54	2530	82	4143	70	3234	64	4899	136	54
55	2448	82	4073	73	3170	66	4763	140	55
56	2366	82	4000	76	3104	70	4623	143	56
57	2284	82	3924	82	3034	75	4480	145	57
58	2202	82	3842	93	2959	79	4335	148	58
59	2120	82	3749	106	2880	84	4187	150	59
60	2038	82	3643	122	2796	88	4037	152	60
61	1956	82	3521	126	2708	90	3885	153	61
62	1874	81	3395	127	2618	91	3732	155	62
63	1793	81	3268	125	2527	93	3577	156	63
64	1712	80	3143	125	2434	95	3421	158	64
65	1632	80	3018	124	2339	100	3263	158	65
66	1552	80	2894	123	2239	105	3105	159	66
67	1472	80	2771	123	2134	108	2946	160	67
68	1392	80	2648	123	2026	111	2786	161	68
69	1312	80	2525	124	1915	115	2625	161	69
70	1232	80	2401	124	1800	115	2464	160	70
71	1152	80	2277	134	1685	115	2304	160	71
72	1072	80	2143	146	1570	115	2144	160	72
73	992	80	1997	156	1455	115	1984	160	73
74	912	80	1841	166	1340	115	1824	160	74
75	832	80	1675	160	1225	114	1664	160	75
76	752	77	1515	156	1111	109	1504	154	76
77	675	73	1359	146	1002	105	1350	146	77
78	602	68	1213	132	897	101	1204	136	78
79	534	65	1081	128	796	96	1068	130	79
80	469	63	953	116	700	93	938	126	80
81	406	60	837	112	607	90	812	120	81
82	346	57	725	102	517	85	692	114	82
83	289	55	623	94	432	83	578	110	83
84	234	48	529	84	349	73	468	96	84
85	186	41	445	78	276	61	372	82	85
86	145	34	367	71	215	50	290	68	86
87	111	28	296	64	165	42	222	56	87
88	83	21	232	51	123	34	166	42	88
89	62	16	181	39	89	22	124	32	89
90	46	12	142	37	67	18	92	24	90
91	34	10	105	30	49	14	68	20	91
92	24	8	75	21	35	11	48	16	92
93	16	7	54	14	24	8	32	14	93
94	9	5	40	10	16	7	18	10	94
95	4	3	30	7	9	5	8	6	95
96	1	1	23	5	4	3	2	2	96
97			18	4	1	1			97
98			14	3					98
99			11	2					99
100			9	2					100
101			7	2					101
102			5	2					102
103			3	2					103
104			1	1					104

approaching. It must therefore be supposed (unless, as before hinted at, specific proof from the records of the office be produced to the contrary) that the discontinuants, or a very large majority of them, lived the whole year of discontinuance in the office. This will make the mortality a little less than that represented in the table, though not much.

There is also a point on which, if our information be correct, the method of forming this table has been misapprehended. Those who study the subject are aware of the thing to which we refer ('Enc. Metr.,' article 'Mortality,' part ii., § 53, note), and will therefore comprehend the following. It is, we understand, the practice of the society in question to make up the registers on the first day of January, at which period every person insured during the previous year is put down as being of the *office age* which he had at his entrance. Now this office age means the age at the next birthday; that is, one with another, parties do not attain their office age till they have lived half a year in the society. But on each first of January the parties insured during the previous year have, one with another, lived half a year in the society, so that they are correctly stated as being of their office age when the registers are made. The preface of this very valuable table is not sufficiently explicit on this and several other points.

4. The Friendly Societies' Table. The materials for this table were collected by the Society for the Diffusion of Useful Knowledge, and were discussed by Mr. Ansell in the work cited above, which should be in the hands of every one interested in the excellent institutions of which it treats. It embraces the history, as to mortality, of 24,323 years of life, among the labouring classes, from all parts of England indiscriminately, and from 1823 to 1828.

The explanation is as follows:—Of 10,000 infants born at Carlisle, 1539 would die in their first year, and 8461 would survive, while 4000 would live to 56 and upwards. In the Equitable Table, of 3922

II. YEARLY RATES OF MORTALITY UPON 10,000 LIVES ACCORDING TO THE NORTHAMPTON, CARLISLE, EQUITABLE, AND FRIENDLY SOCIETIES' TABLES.

Age.	Northampton.	Carlisle.	Equitable.	Friendly Societies.	Age.	Age.	Northampton.	Carlisle.	Equitable.	Friendly Societies.	Age.
0	2575	1539			0	56	347	190	225	309	56
1	1580	789			1	57	359	209	247	325	57
2	689	649			2	58	372	242	267	341	58
3	494	379			3	59	387	283	291	358	59
4	306	287			4	60	402	335	315	376	60
5	294	178			5	61	419	358	332	395	61
6	231	123			6	62	432	374	347	415	62
7	186	88			7	63	452	382	368	437	63
8	138	66			8	64	467	398	390	461	64
9	105	51			9	65	490	411	428	485	65
10	92	45	72		10	66	515	425	469	513	66
11	89	48	72		11	67	543	444	506	543	67
12	90	50	73		12	68	575	465	548	578	68
13	91	52	74	60	13	69	610	491	601	614	69
14	91	55	74	63	14	70	649	516	639	649	70
15	92	62	75	66	15	71	694	588	682	694	71
16	99	67	75	69	16	72	746	681	733	746	72
17	109	69	76	71	17	73	806	781	790	806	73
18	120	70	77	74	18	74	877	902	858	877	74
19	129	70	75	77	19	75	962	955	931	962	75
20	140	71	73	80	20	76	1024	1030	981	1024	76
21	148	69	72	83	21	77	1081	1074	1048	1081	77
22	150	70	72	86	22	78	1130	1088	1126	1130	78
23	153	70	73	89	23	79	1217	1184	1206	1217	79
24	155	71	73	91	24	80	1343	1217	1329	1343	80
25	158	73	76	95	25	81	1478	1338	1483	1478	81
26	160	74	77	98	26	82	1647	1407	1644	1647	82
27	163	78	77	101	27	83	1903	1509	1921	1903	83
28	165	87	78	105	28	84	2051	1588	2092	2051	84
29	168	98	78	109	29	85	2204	1753	2210	2204	85
30	171	101	81	112	30	86	2345	1935	2326	2345	86
31	174	102	82	117	31	87	2523	2162	2545	2528	87
32	177	101	85	121	32	88	2530	2198	2764	2530	88
33	180	101	87	125	33	89	2581	2155	2472	2581	89
34	184	102	91	130	34	90	2609	2606	2686	2609	90
35	187	103	92	135	35	91	2941	2858	2857	2941	91
36	191	106	95	140	36	92	3333	2800	3143	3333	92
37	194	109	99	145	37	93	4375	2593	3333	4375	93
38	198	112	105	151	38	94	5556	2500	4375	5556	94
39	202	119	108	156	39	95	7500	2333	5556	7500	95
40	209	130	110	162	40	96	10000	2174	7500	10000	96
41	216	138	113	168	41	97		2222	10000		97
42	224	144	115	175	42	98		2143			98
43	229	146	116	181	43	99		1818			99
44	235	148	120	187	44	100		2222			100
45	240	148	127	194	45	101		2857			101
46	246	148	129	200	46	102		4000			102
47	252	146	133	207	47	103		6667			103
48	259	139	138	215	48	104		10000			104
49	269	137	142	223	49						
50	284	134	150	233	50						
51	295	143	161	243	51						
52	304	152	173	254	52						
53	314	161	188	266	53						
54	324	169	198	279	54						
55	335	179	208	293	55						

III. MEAN DURATION OF THE LIVES OF 100 INDIVIDUALS OF EVERY AGE, ACCORDING TO THE NORTHAMPTON, CARLISLE, EQUITABLE, AND FRIENDLY SOCIETIES' TABLES.

Age.	Northampton.	Carlisle.	Equitable.	Friendly Societies.	Age.	Age.	Northampton.	Carlisle.	Equitable.	Friendly Societies.	Age.
0	3518	3872			0	56	1510	1689	1634	1539	56
1	3274	4468			1	57	1463	1621	1571	1486	57
2	3779	4755			2	58	1415	1555	1509	1434	58
3	3955	4982			3	59	1368	1492	1449	1383	59
4	4058	5076			4	60	1321	1434	1391	1333	60
5	4084	5125			5	61	1275	1382	1335	1283	61
6	4107	5117			6	62	1228	1331	1279	1233	62
7	4103	5080			7	63	1181	1281	1223	1185	63
8	4079	5024			8	64	1135	1230	1168	1136	64
9	4036	4957			9	65	1088	1179	1113	1089	65
10	3978	4882	4832		10	66	1042	1127	1061	1042	66
11	3914	4804	4767		11	67	996	1075	1011	995	67
12	3849	4727	4701		12	68	950	1023	962	950	68
13	3783	4651	4635	4274	13	69	905	970	915	905	69
14	3717	4575	4569	4199	14	70	860	918	870	861	70
15	3651	4500	4503	4125	15	71	817	865	826	817	71
16	3585	4427	4436	4052	16	72	774	816	783	774	72
17	3520	4357	4370	3979	17	73	733	772	741	733	73
18	3458	4287	4303	3908	18	74	692	733	700	693	74
19	3399	4217	4235	3836	19	75	654	701	661	654	75
20	3343	4146	4167	3756	20	76	618	669	624	619	76
21	3290	4075	4097	3696	21	77	583	640	586	584	77
22	3239	4004	4027	3626	22	78	548	612	549	548	78
23	3188	3931	3956	3557	23	79	511	580	512	512	79
24	3136	3859	3884	3488	24	80	475	551	475	476	80
25	3085	3786	3812	3420	25	81	441	521	441	442	81
26	3033	3714	3741	3352	26	82	409	493	409	410	82
27	2982	3641	3670	3285	27	83	380	465	379	380	83
28	2930	3569	3598	3218	28	84	358	439	357	358	84
29	2879	3500	3526	3152	29	85	337	412	339	338	85
30	2827	3434	3453	3086	30	86	319	390	321	319	86
31	2776	3368	3381	3021	31	87	301	371	303	301	87
32	2724	3303	3308	2956	32	88	286	359	289	286	88
33	2672	3236	3236	2892	33	89	266	347	280	266	89
34	2620	3168	3165	2828	34	90	241	328	256	241	90
35	2568	3100	3093	2764	35	91	209	326	232	209	91
36	2516	3032	3022	2701	36	92	175	337	204	175	92
37	2464	2964	2950	2639	37	93	137	348	175	139	93
38	2412	2896	2879	2577	38	94	105	353	138	106	94
39	2360	2828	2809	2516	39	95	75	353	106	75	95
40	2308	2761	2740	2455	40	96	50	346	75	50	96
41	2256	2697	2669	2395	41	97		328	50		
42	2204	2634	2599	2335	42	98		307			
43	2154	2571	2529	2276	43	99		277			
44	2103	2509	2458	2217	44	100		228			
45	2052	2446	2387	2158	45	101		179			
46	2002	2382	2317	2100	46	102		130			
47	1951	2317	2247	2042	47	103		83			
48	1900	2250	2177	1984	48	104		50			
49	1849	2181	2107	1926	49						
50	1799	2111	2036	1869	50						
51	1750	2039	1966	1813	51						
52	1702	1968	1898	1757	52						
53	1654	1897	1830	1701	53						
54	1606	1828	1764	1646	54						
55	1558	1758	1699	1592	55						

persons attaining the age of 40, 43 and 44 die in the two succeeding years, leaving 3885 surviving at their 42nd birthday.

Of the three species of tables, this is the most useful for mathematical deduction, and the least adapted for a comparative view. The best way of using them for the examination of their relative bearings is to compare the *probable life*, as it is called, of the two, that is, the time in which the numbers living are reduced one-half. Thus taking the age of 31, we see that the numbers living in the Northampton table are halved at the age of 59, while in the Carlisle table this does not happen till the age of 67.

Thus of 10,000 persons attaining the age of 40, 130 die in the following year according to the Carlisle tables; while of 10,000 who attain the age of 41, 138 die in the next year. This species of table is the only one of the three which is immediately applicable to the comparison of two sets of data at and near a given age; while the one to which we now come serves to compare the total character of two sets of data from and after a given age. It also unites the fluctuations of different years, by compensation: thus looking at tables II. we should hardly suspect that closeness of resemblance between the Carlisle and Equitable tables, in the value of life, which is obvious in those marked III.

To avoid decimal points, 100 persons are supposed at each age: thus, 100 persons aged thirty enjoy among them 3086 years, according to the Friendly Societies' tables, or each of them, on the average, 30·86 years. This sort of table is much the best for a running comparison of two laws of mortality.

It must be observed that the two first of the preceding sets of tables attempt a degree of minuteness which cannot be supposed to be attainable with existing data. To distinguish between the decrements of two successive years, and the percentages of the two sets of deaths, would require much greater numbers of living at the two ages than ever have been found in the materials of a table. Nor is the regularity observable in these tables also observable in the observations which produced them; this result being obtained by hypothetical adjustments, so as to attain the nearest representation, in the main, of the materials under investigation. This applies particularly to the old lives, which are but few in number, and present various diversities of fluctuation. Almost all the tables which have been constructed present some general results of utility; and we cannot but think that writers on this subject, by attending too much to minute comparison, and not enough to general indications, have not made all the legitimate deductions which the materials before them would have afforded. We proceed to some general account of the state of mortality, restricting ourselves to the last and present centuries, to life in England only, and to the general variations of mortality and the relative mortality of the sexes.

The circumstance which must strike every one as most remarkable, is the great increase which has taken place in longevity. To put this in a clearer light, we shall collect various tables of the mean duration of life, specifying the epochs of their collection. The tables formed from male lives only, have a capital letter; from female lives only, a small letter; from both, a capital and a small letter. At the bottom of each table is given the period in which all or most of the lives became extinct. The number in the table is the number of years enjoyed by ten individuals: thus in table T, at the age of 20, the mean duration of a single life is the tenth part of 293 years, or 29·3 years.

T t, King William's Tontine	(Finlaison).
L l, London Table	(Simpson).
O o, Norwich Table	(Price).
R r, Chester Tables[*]	(Price).
H h, Holy Cross Table	(Price).
N n, Northampton table	(Price).
A, Amicable Society's Table[†]	
C c, Carlisle Table	(Milne).
E, Equitable Table	(A. Morgan).
G g, Government Annuitants	(Finlaison).
P, Chelsea Pensioners	(Finlaison).
F, Friendly Societies' Table	(Finlaison).

Age.	T	t:	L l,	O o,	R,	r,	H h,	N n,	A:	C c:	E:	G:	g:	P:	F:	Age.
0	376	..	192	232	281	333	339	252	..	387	..	502	555	..	..	0
5	390	424	360	402	432	474	463	408	..	513	..	489	542	..	..	5
10	357	404	348	403	419	452	460	398	..	488	483	456	511	..	..	10
15	320	373	319	375	381	414	423	365	..	450	450	418	472	..	413	15
20	293	343	289	344	349	381	387	334	366	415	417	384	440	318	376	20
25	280	317	261	316	320	348	356	309	341	379	381	359	408	311	342	25
30	263	290	236	289	293	323	327	283	311	343	345	332	376	295	309	30
35	241	263	215	261	260	293	294	257	277	310	309	302	343	279	276	35
40	217	237	196	232	229	264	264	230	244	276	274	270	311	260	246	40
45	192	206	178	203	202	235	234	205	211	245	239	238	278	237	216	45
50	169	178	160	176	176	206	204	180	179	211	204	203	244	212	187	50
55	145	155	142	149	151	175	175	156	151	176	170	172	208	186	159	55
60	116	133	124	124	124	142	149	132	125	143	139	144	173	160	133	60
65	93	102	105	101	108	119	123	109	99	118	111	116	140	132	109	65
70	72	78	88	81	81	88	100	86	78	92	87	92	110	105	86	70
75	56	56	72	64	70	71	79	65	62	70	66	71	85	..	65	75
80	49	38	50	52	54	52	58	48	50	55	48	49	65	..	48	80
85	36	38	..	35	43	48	..	34	40	41	34	31	48	..	34	85
90	20	25	..	15	25	35	..	24	29	33	26	20	28	..	24	90
95	12	16	..	..	..	..	..	8	14	35	11	12	16	..	8	95
	Tontine commenced 1693		1728 to 1737	1740 to 1769	1772 to 1781		1751 to 1780	1735 to 1780	1740 to 1820	1779 to 1787	1760 to 1829	1780 to 1820		1813 to 1821	1823 to 1828	

Comparing tables made from the same sex, or from the mixture of both, that is, looking at T, R, A, E, and G together for the males (P and F are made from the labouring classes exclusively), at t, r, and g for females, and at L l, H h, N n, and O o for both together, the general increase of longevity is sufficiently apparent. The older tables, made from burial-registers, will not prove more than the general fact, uncorrected as they are both for increase of population and migration. The great excess of the Carlisle Table, it must be remembered, is partly owing to the deaths from small-pox having been allowed for, which, though necessary in a table intended for subsequent use among a vaccinated population, prevents the comparison between the Carlisle and preceding tables from being altogether fair. The tables A and F are very similar, and show that the life of the more provident class of labourers (who resort to Friendly Societies) is now as good as those of the Amicable Insurance Office in the last century. That Society is supposed not to have been, in former times, so careful in the selection of lives as the modern institutions of the same kind. This was probably the case, though another circumstance may have operated still more on the table. Up to the year 1808, or thereabouts, no lives older than 45 were taken; so that, while the registers of the Equitable Society have been constantly recruited with selected lives from 45 to 60, as well as at the lower ages, those of the Amicable Society have not had the same advantage above the age of 45. We think however that much of the difference between the two arises from the earlier period which the tables of the latter Society represent.

That the life of a Chelsea pensioner, who is presumed to be a worn-out soldier, should be better than that of the most provident class of labourers, may seem startling at first; but it must be observed that this is only after the age of 40; and the explanation of this circumstance hangs upon another which it is essential to notice.

Let us compare the *relative* lives of the young and old in the different tables; that is, for instance, dividing the life of a person aged 20 into 1000 parts, we ask how many such parts there are found in the life of 60. Ranging the results in order of magnitude, we find that, the life of 20 being 1000 in every table, the life of 60 is as follows:—

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[*] Mr. Lubbock's corrected table ('Library of Useful Knowledge,' PROBABILITY) would have been preferable, but the mean duration is not computed.

[†] Formed some years ago, from the experience of the Society, which has existed since 1706. Their records however can only be said to begin from 1740.

P:	503	t:	388	R,	355
L l,	429	H h,	385	F:	354
T:	396	G:	375	C o	345
N n,	395	r,	372	A:	342
g:	313	O o,	360	E;	333

To show that this distribution does not arise from the method of forming the tables, we have put the comma after all symbols of tables formed from burial-registers (except the Carlisle, which has been in every point too carefully corrected to allow it to rank in method of formation with the rest) and subject to errors of population, and the colon after those tables which have been formed in such a manner that no errors of the preceding kind can appear. It will then readily be seen, as a general result, that old life is relatively longest in those tables in which life in general is absolutely shortest, and that tables formed from female life exclusively hold a mean rank. We have observed the same thing in many other tables, and we think a general explanation can be given. It is well known that the admirers of nature (many of them, at least) formerly included savage life in their panegyrics, and contrasted the uniform good shape and activity of many wild tribes with the frequent deformity and debility of the civilised man: this opinion however has declined since it was remarked that such uniformity of strength was probably a consequence of its being impossible for a disabled or weakened individual to subsist where the highest strength and activity are required to procure common necessaries. Something of the same sort seems to take place with regard to mortality: where the predisposing causes of death are strong and inadequately met, the weaker constitutions swell the tables of mortality at the younger ages, leaving a relatively stronger class to face the chances of more advanced life. Thus in the case of a disabled soldier, he who can last to 60 is half as good, in point of duration, as he was at 20; while the insurer in the Equitable is only one-third as good relatively, and absolutely not nearly so good as the former.

It is sufficiently obvious that female life is better than male, from every comparison of the preceding tables, and almost at every age. To compare these durations, let us suppose ten individuals at every age in T and t, R and r, G and g. If we then take the united amounts of their average lives from 15 to 85, we find that, one age with another, and for equal numbers of males and females similarly distributed,

For 1000 years of male life there are in the	King William's Tontine	1104	Years of female life.
	Chester Tables .	1112	
	Government Tables	1163	

There appears then to have been a slight increase in the comparative goodness of female life: from which those who admit it must conclude that improved medical science and greater accessibility of comforts lengthen the life of females more than that of males. At any rate the other extreme is tolerably well proved by foreign tables, Belgian and Swedish (we have none in this country to settle the point), namely, that when the lives of women are employed in laborious occupations in the open air, they are materially shortened in duration. In Belgium the lives of women living in the country are, on the whole population in the country (mostly labourers, of course), shorter than those of men; while in the towns they are longer, the proportion above-mentioned being that of 1000 to 1071.

On the mortality of the infant periods of life there is but little information. All tables, except the Government Annuitants, unite in showing that the value of life improves up to a period which differs in different tables; being six years of age in the Northampton Table, and five in the Carlisle. With respect to the Government Table it must be observed, that the numbers in the first years of life are small, and also that all the lives are selected. If then it be more easy to select the best lives from among infants than from among grown people, the anomaly of these tables is explained; and the explanation is not difficult to admit, if we remember that the selection is made in most cases by the relations of the party selected, who are perfectly aware both of the state of health of the infant (generally more marked than that of a grown person) and the longevity of its ancestors.

We are of opinion that the Carlisle Table is more likely to represent truly the very old periods of life, not from any greater quantity of materials, but from a better theory having been applied in their formation. It has been very common to end tables with the oldest lives observed in them: thus the Equitable Table ends at 97, because the latest of the deaths from which it was formed (5144 in number) took place at that age. This is not correct in principle, and is the same thing as if, a pair of dice having been thrown a large number of times (say 10,000), it should be inferred that no runs of doublets should ever be calculated on of longer duration than those observed during the course of the throws. In the case of the dice we can calculate beforehand what was the chance of longer runs; and in the table of mortality we have no *à priori* calculation, but only observation of instances: this throws a difficulty in the way, but that difficulty is not properly met by exclusion of all that has not happened as impossible. For the calculations connected with annuities, &c. it is of little consequence, because cases rarely occur in which the purchasing parties are above 80; at which age the chance of living twenty years is so small, that it would not much affect the pecuniary results if those who could get over the period between 80 and 100 years were afterwards supposed to live for ever. But for the determination of the physical laws of the duration of life, such termination of the tables at the oldest age of observed death is wholly inadmissible.

Mr. Babbage has published ('Comparative View of Institutions for the Assurance of Lives,' London, 1826; Table XII., Appendix, from Easton's 'Human Longevity,' Salisbury, 1799) a table formed from 1751 persons who attained the age of 100, which we subjoin, with such additions as will make it correspond with those given before:—

Age.	No. living.	Decrement.	Yearly Rate on 1000.	Mean duration. 100 Persons.	Age.
100	1751	164	94	809	100
101	1587	145	91	786	101
102	1442	162	112	762	102
103	1280	154	120	751	103
104	1126	150	133	745	104
105	976	140	143	755	105
106	836	120	144	772	106
107	716	94	131	794	107
108	622	80	129	806	108
109	542	69	127	817	109
110	473	57	120	830	110
111	416	48	115	836	111
112	368	40	108	839	112
113	328	34	104	835	113
114	294	31	106	826	114
115	263	29	110	817	115
116	234	25	107	813	116
117	209	24	115	804	117
118	185	22	112	801	118
119	163	20	123	803	119
120	143	17	119	808	120
121	126	14	111	811	121
122	112	13	116	805	122
123	99	11	111	804	123
124	88	9	102	799	124
125	79	8	101	784	125
126	71	8	113	767	126
127	63	7	111	758	127
128	56	6	108	746	128
129	50	6	120	730	129
130	44	5	114	723	130
131	39	4	102	709	131
132	35	4	115	684	132
133	31	3	100	666	133
134	28	3	107	632	134
135	25	3	120	582	135
136	22	3	136	577	136
137	19	3	158	561	137
138	16	2	125	556	138
139	14	2	143	529	139
140	12	2	167	508	140
141	10	1	100	500	141
142	9	1	111	450	142
143	8	1	125	400	143
144	7	1	143	350	144
145	6	1	166	300	145
146	5	1	200	250	146
147	4	1	250	200	147
148	3	1	333	150	148
149	2	1	500	100	149
150	1	1	1000	50	150

This table is the necessary consequence of that very large amount of dubious testimony which exists, in various places, upon instances of particular longevity. Looked at separately, there are no means of refuting any one instance; but their united effect is beyond all credibility. The ages of many of these persons must have been ascertained by their own statements of the earliest public events within their memory, and it is not unlikely that very old persons frequently confuse what they have heard talked about in their infancy with what they have seen themselves. There is also a natural tendency to exaggerate great age. Enough however remains, when every possible allowance has been made for error, to show that the remaining life of a person aged 100 years is not so very small as it is generally believed to be; and we strongly suspect that the last 25 years of the Carlisle Table are no exaggeration, but really considerably short of the actual law which prevails among the middle classes of society.

MORTAR. The cementing or binding materials used in building operations, which have a lime base, in one or other of its forms, are known technically by the name of MORTARS; and they are either composed of the ordinary varieties of limes and sand; or of plaster, or of cement, mixed with the same material; or again, in certain cases, of limes mixed with peculiar volcanic productions, such as PUZZUOLANOS and TRASS. The term mortar is therefore a generic one, though its use is almost confined in practice to the mixtures of lime and sand employed for the purpose of building.

In the article LIME, reference has been made to the theoretical conditions affecting the proportions of sand it may be advisable to mix with the respective varieties of that material; but it may be here stated that precisely in the ratio of the expansion of the lime during its absorption of water is it able to support a larger volume of sand for the purpose of mortar making. It thence follows that, as the hydraulic limes, or those which set under water, do not expand much under those circumstances, they support a smaller quantity of sand than the rich, or pure, limes can do. In fact, the best hydraulic limes will not *carry*, to use a workman's phrase, more than about 1½ to 2 proportions of sand to 1 of the lime; both being measured in bulk, and after the slaking of the lime; whilst the rich limes will carry as much as 3 proportions of sand to 1 of lime, when made into mortar. Thus the better a lime is fitted for the purposes of external masonry, the smaller will be the proportion of sand it will bear; and to illustrate this principle by the practice of our London, or southern, builders it may suffice to state, that the chalk lime is usually mixed with 3 portions of sand to 1 of lime; the semi-hydraulic graystone lime, from the chalk-marl, with 2½ sand to 1 lime; whilst the blue-lias lime is mixed with proportions of 1½ sand to 1 lime.

The operation of ordinary mortar making depends for its success upon the energy and the stability of the crystallisation of the lime; for the sand simply acts the part of furnishing a nucleus around which the crystals may arrange themselves, and unless it should happen to contain a notable proportion of silica in the soluble state it will remain chemically inert. Now the pure carbonates of lime yield a caustic lime, which is very easily soluble in water, and which does not crystallise at all when kept in large masses; and the only lime compounds able to solidify under water—whether salt or fresh—are those which contain the various proportions of silicate of alumina, described in the article LIME. It is on this account that in countries, such as Holland, or Central Italy, where the natural limestones are remarkably pure carbonates, it is customary to introduce into the mortars to be employed in hydraulic building the trass and puzzuolanos obtained in the same districts, because those materials are composed of the dehydrised silicate of alumina, which when ground fine will combine chemically with the pure hydrated carbonate of lime. It was supposed that any dehydrised silicate of alumina would produce this result, and the French and German engineers, following the occasional practice of the ancient Romans, actually substituted underburnt-brick dust for the trass or puzzuolano, in some marine walling, and some canal works. But it would appear that peculiar conditions of the silicate of alumina are requisite, at least in the case of mortars intended to resist the action of sea-water; because in almost every instance the mortars composed of pounded bricks, lime, and sand, have disintegrated after a short exposure to the sea; those which were only exposed to the action of fresh water have resisted more successfully, and it is notorious that the Roman mortars possess a very extraordinary hardness and durability, even at the present day. Without dwelling upon these still rather obscure points in the theory of the action of limes, it may suffice here to observe that the above considerations point out the nature of the mortars required for particular positions, or for particular works. Thus, the mortars required for hydraulic works in sea-water must be composed of the most energetic cements, and the latter must even be used without any mixture of sand, if the mortars are intended to be at once exposed to the action of the sea; if, however, the mortars can be protected for a sufficient length of time to allow the crystallisation to take place effectually, the cements may be mixed with sand, or even the best hydraulic limes may be used. For river work, in non-tidal rivers especially, the best hydraulic limes should be used; and for all exposed walling, the common descriptions of hydraulic lime may be resorted to; whilst the purer limes should be reserved for internal works, and for surface renderings of small thickness.

In the preparation of the various mortars the first operation to be performed is the slaking of the lime or cement. In the case of the latter class of materials, which are always ground before being used, the only precaution to be observed is to avoid bringing them into a fluid state; or, in other words, it is advisable only to add enough water to bring them to the consistency of a tenacious modelling clay; especial care being also taken to moisten the stones or bricks to be used simultaneously with them, so as to prevent any absorption of moisture from the cements. In the case of the hydraulic limes, when used without being previously ground, the slaking is performed either in pits or by aspersion, or by immersion; and the object to be obtained is to cause the lime to fall into a fine dry powder, in the state of the hydrate; which powder, however, would not possess the power of crystallising without the addition of a further quantity of water. This additional quantity of water is added at the same time as the sand, introduced for the purpose of affording nuclei around which the crystals of the lime may arrange themselves; and it is indispensable that the whole of the lime in a mortar should have been thoroughly slacked before it is placed in the work. At the present day, in all large building operations the mortar is made by means of PUG-MILLS, or mortar-mills, the latter being formed of large stone or iron wheels revolving in hollow basins; and when those machines are properly used the mortar is more uniform in quality, and more free from *core* than in the ordinary process of manufacture. The core is, in fact, the under-burnt lime, which slakes, when in lump, less quickly than the rest of the lime, and is therefore exposed to take on its action of expansion at a different period; this action would, perhaps, disturb the crystallisation of the rest of the work, and great precautions are required to prevent its occurrence; it is known amongst workmen by the phrase of "the lime blowing." The pure rich limes are more exposed to this class of action than even the hydraulic ones; because in the process of calcination some portions of the limestone become not only *under*, but also others become *over* burnt, and the periods of slaking of the core, produced by either of those causes, differ materially from that of the normal lime. Great care is therefore required in slaking the rich limes, and the old Romans seem to have adopted the custom of slaking them at least three years before the mortars were made; a far greater quantity of water may be used with these limes than with the hydraulic varieties, and indeed the London builders, when about to employ the ordinary chalk lime for plastering purposes, actually *run it*, as they say; or they reduce it to a fluid state and run off the liquid into a tank, where the excess of water is allowed to evaporate. This operation of running would effectually destroy any of the hydraulic limes, and it is important with the latter only to present the quantity of water strictly required for its hydration. Unfortunately working men are so careless that it is practically impossible to ensure the observance of the precaution of keeping the bricks or stones so wet as that they should not be able to abstract moisture from the mortar; and it thus almost always happens that, even in the manipulation of hydraulic limes, a larger quantity of water is used than would theoretically be required.

The mixture of the sand with the lime, or cement, is either effected by hand or by means of the pug-mill; and the proportion above indicated for the various descriptions of lime should be strictly adhered to, and ascertained by actual measurement; the lime itself being slaked, reduced to powder, and measured in that state. In ordinary operations it may not be necessary to observe such extreme accuracy, but for hydraulic works it is essential that all precautions should be taken; and therefore it is equally essential that the proportions of the lime and of the sand should be ascertained by some safer test than the eye of the labourer charged with making the mortar. Be this as it may, the sand to be used for mortar should be a clean, sharp, angular, silicious sand; free from loam, clay, and large lumps of stone, or of oxide of iron: and it must be distributed as equally as possible through the mass.

The mortars obtained by the use of trass and puzzuolano do not contain the same quantities of sand which they would ordinarily do, because the trass, &c., replace it to a very great extent. In the north of Europe it is customary to mix 3 parts of lime in powder, 3 parts of trass, and 3 of sand for hydraulic works; and in the south of Europe, 33 parts of lime with 45 of puzzuolano, and 22 of sand; but the value of these mixtures depends, after all, on the care and attention with which the various ingredients are brought in contact with one another. Occasionally other substances, such as smith's ashes, pounded tiles, the roasted clay nodules of the ironstones, &c., have been mixed with lime and sand in the preparation of mortars; and they communicate to them some unimportant qualities of colour, or even at times some additional powers of setting, which render their use in particular places desirable, as for instance, for pointing old brickwork, or for bedding chimney-pots, or other analogous details of a building which are much exposed to variations of atmospheric conditions. The ordinary pointing mortar is made from the purer rich limes carefully slaked and prepared for the purpose.

In the neighbourhood of Paris the gypsum, or sulphate of lime, is frequently used as a mortar, for walling purposes in positions which are not exposed to much humidity; and this description of mortar is often used as a temporary protection to the slower setting hydraulic lime mortars in sea-water.

MORTAR-BOATS. Under the word GUN-BOATS the present mode of arming small vessels has perhaps been sufficiently noticed. The increased use of shells in naval warfare, to be fired from ordinary cannon, converts, in fact, every ship-of-war into a bomb-vessel; hence the term mortar-boat will not long designate any particular build of vessels, although a few small craft of light draft of water are still so called in the navy, but the term will merge into that of gun-boat.

MORTARS are pieces of ordnance which, compared with guns, are very short, and which are employed to throw shells or carcasses at considerable elevations (generally at 45°, but sometimes as much as 70°), in order that the missile may range to a great distance, and, by falling nearly vertically upon the object (a barrack, magazine, or casemate), may crush it by the momentum acquired in descending. Mortars are either of iron or brass; they rest upon solid beds, and the trunnions or cylinders upon which they turn, in giving the required elevation, are placed at the lower extremity of the piece. A mortar platform, in a battery, should be very strong, in order that it may bear the great recoil or shock of the piece when fired; and it should be carefully laid in a horizontal position.

The calibres of mortars in the British service are 4⅖, 5½, 8, 10, and 13 inches. All these different kinds of mortars are used on land, and the two last are also employed in the navy; but in this latter service the pieces are about 16 inches longer than the land-service pieces of the same calibre, and are much heavier, the sea-service 13 in. weighs 101 cwt. and the land-service 36 cwt. The two first-mentioned are sometimes called royal mortars.

By varying the charge of powder in the same mortar, it has been found that there is a particular elevation which, with each charge, gives a longer range than is obtained from an equal charge at any other elevation. It has also been found that the elevations which give the longest ranges differ much in two mortars of different calibres, but of like proportions, even when charged with quantities of powder bearing the same proportion to the weights of the shells, but for the sake of simplicity they are all generally fired at 45°, and the tables are all arranged for that elevation.

It has been supposed that mortars were employed in the year 1495, at the siege of the castle of Naples, but on no other ground than a statement that artillery of considerable magnitude was conveyed into Italy with the army of Charles VIII. In 1588, however, the use of mortars must have been well known, since, in the Appendix to the 'Colloquies of Tartaglia,' which was published in that year, the method of filling and projecting carcasses is fully described: and it appears that in the same year shells were thrown from ordnance at the siege of Wachtendonk. [BOMB.] Red-hot shot were thrown from mortars at the siege of Bremen, by the Swedes, in 1665.

The first artillerists were somewhat capricious in the formation of their great ordnance; and among the various kinds which they devised may be mentioned what were called Partridge mortars. These had one great central bore for the reception of the shell; and about it, on the face of the muzzle, were sunk thirteen chambers, each of which contained a grenade. The shell and grenades were discharged at the same time, and in the air they must have appeared like a flight of birds; from which circumstance, no doubt, the name of mortar was taken.

The Dutch engineer Coehorn invented a small mortar for throwing grenades into the covered-ways of places. They were capable of being carried about and served by one man; consequently they could be readily brought up to a convenient spot, and rapidly fired when it was intended to drive the defenders from behind the parapets. In the French service *Pierriers* (small mortars loaded with stones) are still employed for the same purpose.

In the year 1771 an experiment was tried at Gibraltar on the discharge of stones from an excavation in the rock. The figure of the excavation is a parabolic conoid, whose axis is 4 feet long, and whose diameter at the muzzle is 3 feet. It was charged with 27 lbs. of powder and 1470 stones; and, on the explosion taking place, nearly one-fourth of the stones were projected to the distance of 100 yards. There are several rock-mortars, as they are called, at Malta, and such may on many occasions be very useful both in the defence and in the attack of a fortified place.

MORTGAGE. A general notion of a mortgage may be collected from the following passage in Littleton (§ 332), who treats of mortgages as then in use, under the general head of estates upon condition.

"If a feoffment be made upon such condition, that if the feoffer pay to the feoffee, at a certain day, 40*l*. of money, that then the feoffor may re-enter, &c.,—in this case the feoffee is called tenant in morgage, which is as much to say, in French, as *mortgage;* and in Latin, *mortuum vadium*. And it seemeth that the cause why it is called mortgage is, for that it is doubtful whether the feoffor will pay, at the day limited, such sum or not: and if he doth not pay, then the land, which is put in pledge upon condition for the payment of the money, is taken from him for ever, and so dead to him, upon condition, &c. And if he doth pay the money, then the pledge is dead as to the tenant, &c."

The money thus agreed to be paid by the feoffor must be supposed to be money borrowed from the feoffee, or the amount of a debt due from the feoffor to the feoffee, though Littleton does not expressly say so. According to the terms of this contract, if the feoffor or the feoffor's heir did not pay the money at the time appointed, the land became the absolute property of the feoffee.

The mortuum vadium of Glanville (book x.) is evidently a different thing from the mortuum vadium of Littleton, and Glanville's explanation of the term seems more applicable to his mortuum vadium, than Littleton's is to the mortgage which he describes. "When an immovable thing," says Glanville, "is put into pledge, and seisin of it has been delivered to the creditor for a definite term, it has either been agreed between the creditor and debtor that the proceeds and rents shall in the meantime reduce the debt, or that they shall in no measure be so applied. The former agreement is just and binding; the other unjust and dishonest, and is that called a mortgage, but this is not prohibited by the king's court, although it considers such a pledge as a species of usury." (Beames' *Transl.*)

Littleton describes the old and strict law of mortgage; but the courts of equity gradually introduced such modifications as to convert a mortgage from its ancient simplicity into a very artificial and complicated arrangement. A mortgage is a contract, and therefore requires two persons at least, one of whom borrows and the other lends money. The borrower is the owner of land which he conveys or transfers as a security to the lender of the money: the borrower is called the mortgagor, and the lender is called the mortgagee. The *whole* transaction is properly termed a mortgage; but the name is sometimes applied simply to the debt. The nature of this contract, as it is now understood, will best appear from a brief enumeration of the essential terms of the instrument called a mortgage deed. For the sake of simplicity, the case of a mortgage in fee may be taken as the example; and the remarks which follow must be considered as applicable to that description of mortgage.

The instrument of mortgage is a deed indented. It commences by reciting that the mortgagor is the owner in fee simple of the lands which it is intended by the deed to convey to the mortgagee, and that the mortgagee has agreed to lend him a certain sum of money on the security of the lands. It is then declared that, in pursuance of the said agreement, the mortgagee has paid to the mortgagor the sum of money which he (the mortgagee) has agreed to lend. The mortgagor then conveys to the mortgagee and his heirs the lands in question, with a condition that if the mortgagor, his heirs, executors, administrators, or assigns, shall pay to the mortgagee, his executors, &c., the sum of money borrowed, with interest for the same at the rate in the instrument mentioned, upon a future day, which is named in the deed (generally a year from the date of the mortgage deed), without any deduction or abatement whatsoever, the deed shall then cease and be void to all intents and purposes, or that the mortgagee shall reconvey the premises to the mortgagor. In addition to this conveyance of the lands, the mortgagor promises and undertakes to pay the principal money borrowed, and interest on the same, at the rate and at the time before mentioned in the instrument; and he also covenants (as the legal phrase is) that he has full right to convey the lands in the manner expressed in the previous part of the instrument. It is further agreed that, after the mortgagor shall have failed to pay the principal sum of money, and interest, or any part thereof, as before agreed, the mortgagee, his heirs, or assigns, may take possession of the lands so conveyed as aforesaid, and use and enjoy them, and take the rents and profits, without any hindrance or interruption from the mortgagor his heirs, executors, administrators, or assigns, or any other person or persons. It is also provided that until the mortgagor shall have made such default in payment as aforesaid, he, his heirs, or assigns, shall hold and enjoy and receive the rents and profits of the lands without any interruption or hindrance from the mortgagee, his heirs, or assigns. In many mortgage deeds it is also provided, that if the principal money and interest, or any part thereof, are not paid at the time agreed on, the mortgagee may sell the mortgaged lands (giving proper notice to the mortgagor of such his intention, if notice is provided for by the instrument): it is also provided that after paying out of the proceeds of the sale, and out of any rents or profits which he may have received from the lands, the costs and expenses of the sale, and all other expenses incurred in the execution of the trust for sale, and retaining what is due to him for principal and interest, the mortgagee must pay the surplus, if any, to the mortgagor, his heirs, executors, administrators, or assigns, or as he or they shall direct. In deeds which contain a power of sale, it is usual to insert a proviso, that such power of sale is not to destroy or prejudice the mortgagee's right of foreclosure.

These are the essential parts of a mortgage-deed, which is varied according to the estate or interest in the lands which the mortgagor conveys to the mortgagee, and according to the special agreement of the parties. By the execution of the deed, the estate of the mortgagor in the lands mortgaged is conditionally transferred to the mortgagee, but the mortgagor's estate is not forfeited till he makes default in payment of the money borrowed and interest at the time named in the deed. The money borrowed is however seldom paid at the time agreed on, the consequence of which is that the mortgagor's estate is forfeited by his not fulfilling the condition, and the mortgagee becomes the absolute legal owner of the land, or of such estate in it as was conveyed to him. He can then bring an action of ejectment against the mortgagor, if the mortgagor is in possession of the land, without giving him notice; and he can do this even before default in payment, unless it is agreed by the mortgage-deed that the mortgagor shall remain in possession till he makes default, and a clause to this effect is commonly inserted in the deed. After the mortgage is made, the mortgagor cannot make a lease of the lands without the mortgagee's consent, for he has no interest in the land out of which he can create a legal estate; and if any such lessee gets possession of the land, the mortgagee may eject him. But the lessee who claims by a title prior to the mortgage is not affected by the mortgage transaction, though, after default is made and he has notice from the mortgagee, he is bound to pay to him the future rents and those which are then due.

There has been considerable discussion as to the nature of the relation of the mortgagor in possession and the mortgagee; and this relation has been supposed to be that of tenant and landlord, the nature of the tenancy varying according as we contemplate it before or after default. But this seems an erroneous view of the legal effect of the contract, and the supposition of a tenancy is perfectly useless for the explanation of the rights either of the mortgagor or mortgagee, which are determined by the instrument of mortgage, and by the well-established jurisdiction of courts of equity in matters of mortgage.

From the time of default being made, the several interests of the mortgagor and the mortgagee in the land must be considered as chiefly belonging to the jurisdiction of equity. When the mortgagee, by default of the mortgagor, has become the absolute legal owner of the lands, the mortgagor possesses what is called the equity of redemption. This equity of redemption is considered by courts of equity as an estate in the land: it may be devised by the mortgagor, and, in case of his intestacy, it will descend to his heir; it may be sold, or it may be mortgaged; it is subject both to dower (in equity, by 3 & 4 Wm. IV., c. 105) and curtesy; and it may be settled like a legal estate.

By the statute 1 Vict., c. 28, made for the purpose of explaining the statute of limitations (3 & 4 Wm. IV., c. 27), it was enacted, That any person entitled to or claiming under any mortgage of land (as defined by the last-mentioned act) may make an entry or bring an action at law or suit in equity, to recover such land, at any time within twenty years next after the last payment of any part of the principal money or interest secured by such mortgage, although more than twenty years may have elapsed since the time at which the right to make such entry or bring such action or suit in equity shall have first accrued. This act was passed to protect the mortgagee who allows the mortgagor to continue in possession of the land or in the receipt of the rents and profits; and it secures to him his rights for twenty years after the last payment of principal or interest by the mortgagor. By the 3 & 4 Wm. IV., c. 27, when a mortgagee has got possession of the land or receipt of the profits, the mortgagor, or the person claiming through him, can only bring a suit to redeem the lands within twenty years next after the commencement of such possession or receipt, or within twenty years from the time when the mortgagee or the person claiming through him last acknowledged in writing to the mortgagor, or some person claiming his estate, or to the agent of such mortgagor or person, his title of mortgagor or right to redemption. The mortgagor, or the person claiming under him, may therefore, at any time within the limits above-named, tender to the mortgagee his principal money and interest, and claim a reconveyance of the lands; and if the mortgagee will not accept the tender and reconvey, the mortgagor may compel him by filing a bill in equity for the redemption of his lands.

A mortgagee can transfer his mortgage to another. The transfer or assignment as it is generally called, consists of two parts expressed in one deed, the transfer of the debt, and the conveyance of the land, which is the security for the debt. If the mortgagor is not a party to the assignment, the assignee takes the mortgage exactly on the terms on which the assignor held it at the time of the assignment. If therefore the mortgagor should happen to have paid the whole or any part of the debt, the assignee, in coming to a settlement with him, must submit to allow such payment in diminution of the original debt which the assignor affected to assign to him.

Though the mortgagee, after the mortgagor's default in payment of the principal money and interest, has the absolute legal estate, he is still considered by courts of equity only to hold it as a security for his debt. The legal estate in the land will descend to the mortgagee's heir, or will pass by his will, if duly executed; but the heir or devisee takes only the legal estate in the land, and the money or debt (as a general rule) belongs to the mortgagee's administrator or executor.

If the principal money and interest are not paid at the time agreed on, the mortgagee may file a bill of foreclosure against the mortgagor. By such bill the mortgagee calls on the mortgagor to redeem his estate forthwith, by payment of the principal money, interest, and costs; and if the mortgagor does not do this within the time named by the decree of the court (which is generally within six months after report has been made of what is due for principal, interest, and costs), he is for ever foreclosed and barred of his equity of redemption, and the mortgagee becomes the owner of the land in equity, as he was before at law. If the money is paid at the time named, the mortgagee must reconvey the land, and deliver up to the mortgagor all the deeds and writings in his possession relating to the land.

If both the mortgagor and mortgagee are living at the time when the lands are redeemed, and nothing has been done by either party to assign or transfer his interest to any other person, the transaction is a very simple one: the mortgagor pays his debt and interest, and the mortgagee reconveys the lands. The settlement of accounts between the mortgagor and mortgagee may be rendered more difficult by the circumstance of the mortgagee having received the rents, for which the decree for redemption provides that he must account. It may however happen that the mortgagor or mortgagee is dead, or that they have severally disposed of their interests in the lands, or all these events may have happened, which renders the settlement much more complicated.

To take the case of mortgagor and mortgagee being dead. As every mortgage transaction implies a debt from the mortgagor to the mortgagee, which he is bound to pay, even if there are no covenants for payment in the mortgage-deed, it followed that, according to the general rule of law, his personal estate was in the first instance liable to pay the mortgage debt, unless he had by his will made a different provision for payment of it. Thus the heir or devisee of the equity of redemption might be entitled to call on the administrator or executor to pay the mortgage debt. If however the lands in question were not mortgaged by the intestate or devisor, but the equity of redemption descended or was devised to him from or by the mortgagor, or if he purchased the equity of redemption, his personal estate was not liable to pay the mortgage debt; but the person who derived his title to the land from such intestate, devisor, or purchaser, took it subject to the burden of the mortgage debt, and this is still the law as to lands devolving under wills dated previously to the 1st of January, 1855. For other cases the law is now altered by 17 & 18 Vict., c. 113, so that land in mortgage passes to the heir or devisee *cum onere*.

When a mortgage deed contains a power of sale, which is exercised in the lifetime of the mortgagor, the surplus money is personal estate; but if the sale is effected after the mortgagor's death, the money belongs to his heir or the devisee of the lands.

The person entitled to receive the debt is the administrator or executor of the mortgagee; for, as already observed, the land is only considered as a security for the debt, which the mortgagor has bound himself, his heirs, executors, and administrators, to pay to the mortgagee, his executors, administrators, and assigns. Thus, whether the mortgagee dies without having or after having assigned his mortgage, the money is a debt due to the personal representative of the mortgagee, or to his assignee, or to the personal representative of the assignee, if the assignee is dead. When the debt is received by the person entitled to receive it, the person who has the legal ownership of the land, whether he be heir or devisee, is bound to convey it to the person who, on the payment of the debt, becomes entitled to the legal estate. In such case, on payment of the debt to the person entitled to receive it, the heir or devisee is by a fiction converted into a trustee for the person entitled to the land. The mortgagee may, however, by express declaration, convert the mortgage debt into land (according to the technical expression), and make it pass as land by his will, in which case the devisee will have the same title to the money as he would have had to the land if it had been absolutely the property of the mortgagee.

When the mortgagor has mortgaged his equity of redemption (which he may do as often as he pleases), every new mortgagee has his claim on the land as a security for his debt, according to the order in which his mortgage stands. This is the general rule; but it is subject to various exceptions, which depend on particular circumstances. Thus a mortgagee of the equity of redemption will be postponed, as to his security, to a subsequent mortgagee who has advanced his money without notice of the prior mortgage, if such subsequent mortgagee should be able to obtain the legal estate.

If a second mortgagee obtains the title-deeds of the estate, this will not give him a preference over a prior legal mortgagee, unless the prior mortgagee has parted with or failed to get possession of the title-deeds for fraudulent purposes, or through gross negligence. But though the second mortgagee has no priority, when there is neither fraud nor negligence, he will not be compelled to give up the title-deeds to the first mortgagee, unless the first mortgagee pays him his debt and interest.

A legal mortgage is effected by an instrument which transfers the legal estate. When a mortgagor makes a second mortgage, and uses the form of a legal conveyance, this also is called a legal mortgage, though there is no transfer of any legal estate, for the legal estate is already conveyed to another person. This kind of mortgage may be called a mortgage of an equity of redemption, by way of distinguishing it from the equitable mortgage next mentioned. An agreement in writing to transfer an estate as a security for the repayment of a sum of money, is called an equitable mortgage, because it gives the intended mortgagee a right to have a legal mortgage, and in a court of equity gives him in fact all the rights of a legal mortgagee. A deposit of the title-deeds of an estate, or of the copy of court-roll, as a security for a debt contracted at the time of the deposit, or previously to the deposit, constitutes an equitable mortgage. An equitable mortgagee, by deposit of title-deeds, has a preference over a subsequent purchaser or mortgagee who obtains the legal estate with notice of the equitable mortgage.

If the mortgagor is not seised in fee, but has only a limited interest in land, as a lease for years, the mortgagor by taking an assignment of the lease, becomes liable for the rent, and to the covenants contained in the lease, though he has never taken possession of the premises included in it. The same rule was for a time held to apply to an equitable mortgagee by deposit of title-deeds [Lease]; but in a recent case it was decided that the equitable mortgagee is not liable to such covenants (Moores *v.* Choat, 8 Sim. 508), and so the matter stands at present. See also Moore v. Greg, 2 Phill., 724.

The preceding remarks apply to mortgages of land only, in which there are many peculiarities which arise from the condition of legal ownership of land in this country. But other kinds of property may be mortgaged, such as chattels personal, a life-interest in a sum of money, or a policy of insurance, or a ship, or shares in a ship. The subject of pawning or pledging of goods is treated under Pledge, and also the rules of the Roman law as to Hypotheca and Pignus. The equitable lien on land, which is classed among mortgages by some writers, is briefly noticed under Lien; and mortgages of ships under Ship.

No attempt has been made to lay down all or the greater part of the rules applicable to mortgages. The explanation of these rules would fill a large volume. The general principles of all mortgages are however here laid down, and the reader must consult professional books for particular cases.

MORTIFICATION (in Medicine) is the death of any tissue. It may occur from a variety of causes, as intense inflammation [Inflammation], or from anything which is followed by a cessation of the circulation of blood through a part, as diseases of the arteries and veins, the pressure of tumours and foreign bodies, excessive debility, &c., or from any sudden and violent chemical or mechanical agent, as strong acids or other corrosive substances, excessive heat or cold, violent blows, &c. The process of reparation consists in the separation of the living tissues from the dead, the removal of the latter by absorption or by being thrown off externally, and the granulation and cicatrisation of the exposed surface of the former.

MORTMAIN. By the 9 Hen. III. c. 36 (Magna Charta), it was declared that it should not be lawful for the future for any person to give his land to a religious house, so as to take it back again and hold it of the house; and any such gift to a religious house was declared to be void, and the land was forfeited to the lord of the fee. The reason of this provision is obvious, if we consider the nature of the feudal tenure; and indeed it is distinctly expressed in the preamble of the statute of the 7 Edward I., sometimes entitled 'De Religiosis,' as follows:—"Whereas of late it was provided that religious men should not enter into the fees of any without the licence and consent of the chief lords (capitalium dominorum) of whom such fees are immediately held; and whereas religious men have entered as well into fees of their own as those of others, by appropriating them to their own use and buying them, and sometimes receiving them of the gifts of others, by which means the services due from such fees, and which were originally provided for the defence of the realm, are unduly withdrawn and the chief lords lose their escheats of the same," &c. The statute then forbids any religious person or any other to buy or sell lands or tenements, or under colour of a gift or term of years, or any other title whatever, presume to receive from any one, or by any other means, art, or contrivance, to appropriate to himself lands or tenements, so that such lands or tenements come into mortmain in any way (*ad manum mortuam deveniant*), under pain of forfeiture of the same. The statute then provides, that if it be violated, the lord of whom the lands are holden may enter within a year; or if he neglect to enter, the next lord may enter within half a year; and if all the chief lords of such fees, being of full age, within the four seas, and out of prison, neglect to enter, the king may enter.

The general notion of mortmain may be collected from the words of this statute, the term being used to express lands belonging to any corporate body, ecclesiastical or temporal, sole or aggregate. Various explanations have been offered as to the reason why lands of this description were said to be in mortmain, or in *mortua manu;* that is, in a dead hand. Under the feudal system, lands held by any corporate body or person might not inappropriately be said to be in a dead hand as to the lord of the fee; for as a corporation has perpetual continuance and succession, the lord lost the profits in his lands which, under the strict system of tenures, he derived either from the services of the tenant, while alive, or from the death of the tenant and other circumstances incident to such event. Accordingly, the best explanation of the meaning of this term seems to be that offered by Coke, that "the lands were said to come to dead hands as to the lords, for that by alienation in mortmain they lost wholly their escheats, and in effect their knights' services for the defence of the realm, wards, marriages, reliefs, and the like, and therefore was called a dead hand, for that a dead hand yieldeth no service." Similarly, the old *mortuum vadium* seems to have been so called because the land in pledge was for the time dead to the pledger. [Mortgage.]

Before the 9th Hen. III. c. 36 was passed, a man might give or sell his lands to religious as well as any other persons, unless it was forbidden in the gift of the lands to himself; and, accordingly, the great lords, on making a grant of land, used to insert a clause preventing the sale or gift to religious and also to Jews: "Licitum sit donatorio rem datam dare vel vendere cui voluerit, exceptis viris religiosis et Judeis." (Bracton, fol. 13.)*

This statute of Edward I. prevented gifts and alienations between corporate bodies or persons and others; but it was eluded by a new device, apparently invented by the clergy, and probably most used by the religious houses. These bodies, pretending a title to the land which they wished to acquire, brought an action for it by a *præcipe quod reddat* against the tenant, who collusively made default, upon which the religious house had judgment, and entered on the land.

The statute of the 13 Edward I. (Westminster, 2), c. 32, provided against these recoveries of lands obtained by collusion; for it was enacted, that after the default made, it should be inquired whether the demandant had any right in his demand or not; and if the demandant were found to have no right, the land was declared to be forfeited to the lords mediate and immediate, similarly as was provided by the previous statute of Edward I. Another provision of this statute (c. 33) furnishes curious evidence as to the devices practised for the purpose of eluding the statutes of mortmain. The words of the enactment will best explain the allusion:—"Forasmuch as many tenants set up crosses or permit them to be set up on their tenements, to the prejudice of their lords, in order that the tenants may defend themselves by the privileges of Templars and Hospitallers against the chief lords of the fees, it is enacted, that such tenements be forfeited to the chief lords, or to the king, in the same way in which it is enacted elsewhere with respect to tenements alienated in mortmain" (*de tenementis alienatis ad mortuam manum*).

Various other statutes were passed in the reigns of Edward I. and Edward III. relating to mortmain; but the next important statute is that of the 15 Richard II., c. 5. As corporations could not now acquire lands by purchase, gift, lease, or recovery, they had contrived another new device, said to be mainly the invention of or mainly practised by ecclesiastical bodies or persons. The device consisted in this: the lands in question were conveyed to some person and his heirs to the use of the ecclesiastical body or person and their or his successors. In this way the legal estate was not in the possession of those who could not legally hold it, but in a person who had such legal capacity; and the use or profit of the land, the beneficial interest in it, was secured to the ecclesiastical body or person, contrary to the spirit of the previous statutes, though not contrary to their expressed provisions. The statute of Richard, after declaring that this use was also mortmain, further declared all such conveyances to be void, and that the lords might enter on lands so conveyed, in the manner provided for by the statute De Religiosis. This distinction of the ownership of land into the legal and beneficial was undoubtedly derived by the clergy from the like distinction in the Roman law between *quiritarian* and *bonitarian* ownership, which is briefly and distinctly expressed by Gaius (ii. 40).

Though the statute De Religiosis was in its terms comprehensive enough to include all alienations to corporate bodies or persons, it is clear that this statute was mainly directed against the clergy, both regular and secular. The ecclesiastical corporations were more numerous than any other, and had been more active in getting lands into their hands. This statute of Richard II., however, expressly extends the statute De Religiosis to lands purchased to the use of guilds or fraternities, from which it has been inferred that the doctrine of mortmain had not, before the date of this statute, applied to guilds or fraternities. The statute De Religiosis is by this statute of Richard II. expressly declared to apply also to what we now call municipal corporations, and the statute places such bodies in all respects on the same footing, as to the purchase of lands, with "people of religion." If such bodies as these had been considered within the statute De Religiosis, it seems clear from the statute of Richard II. that their acquisitions of land had only recently become of such magnitude as to make it seem expedient to make a special declaration by statute as to them.

A statute of Henry VIII. (23 Henry VIII., c. 10), commonly called an Act against superstitious uses, is perhaps hardly a statute against mortmain in the strict sense of the term. The statute enacted that feoffments, fines, recoveries, and other estates, made of lands and hereditaments to the use of parish churches, chapels, guilds, fraternities, commonalties, &c., erected and made of devotion or by common consent of the people without any corporation, or to uses for perpetual obits, or a continual service of a priest, were declared to be void as to such gifts as were made after the 1st of March in the year in which the statute was passed, for any term exceeding twenty years from the creation of such uses. From the words "by common consent of the people, without any corporation," it can hardly be inferred that a number of individuals could take in perpetual succession without being incorporated, as some writers suppose; for "to take by perpetual succession without being incorporated" involves a contradiction. Nor can the statute be construed as admitting by implication such a power of perpetual succession in unincorporated individuals. The statute destroys all such estates and interests in land as in any way or by any persons were held to the use of the establishments or collections of individuals mentioned and described in the statute.

The subsequent statutes passed in the reign of Henry VIII. (27 Hen. VIII., c. 28; 31 Hen. VIII., c. 13; 37 Hen. VIII., c. 4), together with the statute passed in the first year of Edward VI. (1 Edw. VI., c. 14), put an end to religious houses and many other establishments which had been the special objects of the statutes of mortmain and superstitious uses. The consideration of what are now legally called superstitious uses properly comes under the head of Uses, Superstitious and Charitable.

The king could always grant a licence to alien in mortmain, or, more correctly speaking, he could remit the forfeiture consequent upon alienation, so far at least as concerned himself; but such remission could strictly only affect his own rights, and not those of the mesne lords, unless they also consented. It was the practice, before the king granted his licence, to sue out a writ of *ad quod damnum*, in order that inquiry might be made and the king informed what damage himself or others might sustain from the licence. This practice however fell into disuse long before the statute of the 7 & 8 Will. III., c. 37, which authorises the king to grant to any person or persons, corporate or not, licence to alien in mortmain, and to purchase and hold in mortmain any lands or hereditaments, and that such lands shall not be subject to forfeiture. When a licence to hold lands in mortmain is granted, it generally specifies the amount in value of the lands to be held by the corporation to which it is granted, and if the corporation should be ever found to acquire lands beyond this value, such lands are forfeited to the lord.

Until the statute of 9 Geo. II., c. 36, presently mentioned, though lands could not be aliened in mortmain, yet certain gifts to corporate bodies were held good. Thus, if a feoffment was made to a dean and chapter to perform a charitable use (within the 43 Eliz., c. 4), it was good, though they could not be seised to another's use; and a devise to a college to a charitable use within this statute was also good. (Hob., 136; 1 Lev., 284.)

The statute of the 9 Geo. II., c. 36, is now commonly, though not correctly, called the Statute of Mortmain. It applies only to England and Wales. It is entitled "An Act to restrain the Disposition of Lands, whereby the same become inalienable." The provisions and object of this enactment cannot be otherwise expressed than by stating the first section at full length:—"Whereas gifts or alienations of lands, tenements, or hereditaments, in mortmain, are prohibited or restrained by Magna Charta and divers other wholesome laws, as prejudicial to and against the common utility; nevertheless this public mischief has of late greatly increased by many large and improvident alienations or dispositions made by languishing or dying persons, or by other persons, to uses called charitable uses, to take place after their death, to the disherison of their lawful heirs; for remedy whereof be it enacted, that from and after the 24th day of June, 1736, no manors, lands, tenements, rents, advowsons, or other hereditaments, corporeal or incorporeal whatsoever, nor any sum or sums of money, goods, chattels, stocks in the public funds, securities for money, or any other personal estate whatsoever, to be laid out or disposed of in the purchase of any lands, tenements, or hereditaments, shall be given, granted, aliened, limited, released, transferred, assigned, or appointed, or any ways conveyed or settled to or upon any person or persons, bodies politic or corporate, or otherwise for any estate or interest whatsoever, or any ways charged or encumbered by any person or persons whatsoever, in trust or for the benefit of any charitable uses whatsoever, unless such gift, conveyance, appointment, or settlement of any such lands, tenements, or hereditaments, sum or sums of money, or personal estate (other than stocks in the public funds), be made by deed indented, sealed and delivered, in the presence of two or more credible witnesses, twelve calendar months at least before the death of such donor or grantor (including the days of execution and death), and be enrolled in His Majesty's High Court of Chancery within six calendar months after the execution thereof; and unless such stock be transferred in the public books usually kept for the transfer of stocks, six calendar months at least before the death of such donor or grantor (including the days of the transfer and death); and unless the same be made to take effect in possession for the charitable use intended immediately from the making thereof, and be without any power of revocation, reservation, trust, condition, limitation, clause, or agreement whatsoever, for the benefit of the donor or grantor, or of any person or persons claiming under him." The act provides that what relates to the time before the grantor's death for sealing the deed and making the transfer shall not extend to any purchase to be made really and bonâ fide for a full and valuable consideration, actually paid at or before the making of such conveyance or transfer without fraud or collusion. The two universities of Oxford and Cambridge, and the colleges within them, were excepted from the operation of the act; and the colleges of Eton, Winchester, and Westminster, but in favour of the scholars only, were also excepted. This act limited the number of advowsons which any college or house of learning (before referred to in the act) could hold; but this restriction was removed by the 45 Geo. III., c. 101. By the 5 Geo. IV., c. 39, the British Museum is excepted from the statutes of mortmain; and various other public bodies have been in like manner excepted by act of parliament. The judicial interpretation of this act, called the Mortmain Act, has prevented a large amount of property from being given to charitable uses. A bequest of money for charitable purposes, to arise from the sale of land, is void; or of money due on mortgages; or of money to pay off the mortgage on a chapel; or of money to build a chapel, unless some land already in mortmain is distinctly pointed out by the terms of the bequest; or of mortgages both in fee and for years; or of money to be laid out on mortgage security. This act can only be called a Mortmain Act with any propriety so far as it relates to corporate bodies, and even with regard to them with no strict propriety, inasmuch as the Mortmain Acts were intended to prevent corporate bodies holding lands to their own use, or to prevent other persons holding them to the use of corporate bodies. The act is in fact intended to limit the power of giving property for charitable purposes to any person or persons, and is very improperly called a Mortmain Act, if we consider that many gifts of land for charitable purposes were not considered, before the passing of this act, as within the old statutes of mortmain.

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* Viner (art. 'Mortmain'), quoting Coke, who writes this passage "Licitum sit *donatori*," says, "Quære if it should not be *donato*, donee." Such a blunder might have been avoided by looking at the original, or might have been corrected even without doing so.

The history of mortmain is intimately connected with the ecclesiastical and civil history of this country. The jealousy which all mankind feel against rich and powerful bodies of men, who are combined in a perpetual brotherhood and fraternity, and the constantly increasing wealth and power of the ecclesiastical bodies in this country, doubtless contributed strongly to the passing of the enactments called the statutes of mortmain; and this, independently of the solid reasons against such bodies having large possessions, so long as the strict system of tenures continued. In modern times, when the lord can lose nothing by land being conveyed to a corporation or to a charitable use, except the remote contingency of escheat, a new notion lies at the foundation of the restraints upon such transfers or gifts of land, which, as Lord Hardwicke expressed it, was this:—

"The mischief which the legislature had in view in the Mortmain Act (as appears from the recital, and which is agreeable to the title) was to restrain the disposition of lands whereby they become inalienable." In another place he observes that "the particular views of the legislature were two: first, to prevent locking up land and real property from being aliened, which is made the title of the act; the second, to prevent persons, in their last moments, from being imposed on to give away their real estate from their families."

It will be perceived that the provisions of the act very imperfectly correspond with this explanation of its object. Thus money may be given by will (if unaccompanied with a direction to lay it out in land) to an eleemosynary corporation which is empowered to hold land in mortmain, and it may be laid out in land, or, if necessary, a licence may be obtained from the crown for that purpose. The judicial exposition, that money given by will, to arise from the sale of lands, is within the act, involves a direct contradiction; it being expressly provided by the mode of donation, in the case just mentioned, that the land shall *not*, so far as the donor can prevent it, come into hands in which it will be inalienable.

The act, which is but a clumsy contrivance, and the exposition of it, are in fact directed against gifts for charitable uses; though it is probable that the notion of the impolicy of allowing lands to be for ever set apart, or "locked up," had also some influence on the legislature. If this, however, had been the leading idea, a repeal of the statute which allows the crown to grant a licence to hold lands in mortmain would have been a proper addition to the act. But the legislature or the promoters of the act were apparently anxious to find out some reason or excuse for passing such an act in a country where gifts for charitable uses have been so long established and approved by popular opinion. The exceptions made in this act in favour of the universities and colleges also show that there was a party in the legislature strong enough to prevent the operation of this act being extended to those corporate bodies.

It should be borne in mind that the terms charities and charitable uses have a legal meaning very different from the popular meaning of the term charity.

The great amount of property in England and Wales which is appropriated to charitable uses, and the importance of many of those establishments which are supported by such property, render it necessary to give some exposition of the nature and administration of charities in this country, which is most conveniently done under the head of USES, CHARITABLE.

The term *Mortification* in Scotland expresses pretty nearly what mortmain does in England.

According to Stair (book ii., tit. iii., 39, ed. Brodie), "infeftments of mortified lands are those which are granted to the kirk or other incorporation having no other *reddendo* than prayer and supplications and the like: such were the mortifications of the kirk lands granted by the king to kirkmen, or granted by other private men to the provost and prebendars of college kirks founded for singing; or to chaplainries, preceptories, altarages, in which the patronage remained in the mortifiers." The act of 1587, c. 29, passed in the eleventh parliament of James VI., began by reciting that the king "and his three estaites of parliament perfitely understood the greatest part of his proper rent to have bene given and disponed of auld to abbaies, monasteries, and utheris persons of clergie," &c.: it further recited that "his Hienes, for the great love and favour quhilk he bearis to his subjectes, was nawaies minded to greeve them with unprofitable taxations, specially for his royal support." The act then went on to declare that it was "founde maiste meete and expedient that he sall have recourse to his awin patrimony disponed of before (the cause of the disposition now ceasing) as ane helpe maist honorable in respect of himselfe and least grievous to his people and subjectes." The act then proceeded to unite and annex to the crown (with the exceptions after specified in the act) all the lands, &c., belonging to the ecclesiastical and religious personages therein mentioned. This act was in effect more extensive than the similar acts of Henry VIII. in England.

Since the Reformation, lands given in Scotland for charitable purposes are given to the trustees of the charity, to be held either in blanch or feu holding. (Bell's 'Dict. of the Law of Scotland.')

MORTUARY, from the Latin *mortuarium*, by our Saxon ancestors called ꞅaul-ꞅceat, soul-shot, or money paid at death. The mortuary was really a gift left by a man to his parish church, as a recompense for his personal tithes and offerings not duly paid. Dugdale, in his 'History of Warwickshire,' p. 679, enters minutely into the reason and original occasion of such bequests, the earliest mention of which he finds in the 'Council of Ænsham,' in the year 1009, and in the 'Laws of King Canute.' Mortuaries were afterwards distinguished into dead mortuaries, and *mortuaria viva*, or live mortuaries: the former consisting of money, or any other goods or chattels; the latter of livestock: Blount says the second-best beast, after the first had been paid to the lord for his heriot. After the Conquest we find the mortuary sometimes called a *cors-present*, because the beast was presented with the body at the funeral. John Arden, in his will dated 4th of June, 17 Hen. VIII., says, "Item, I bequeath for my mortuary, or corspresente, a black gelding ambling, that Almighty God may the rather take my soul unto his mercy and grace." Dugdale quotes several ancient wills from the time of Hen. III. to that of Henry V., in which horses, caparisoned and bearing the military weapons of the defunct, are directed to be led before the corpse at his funeral, and delivered as mortuaries. This was the origin of the practice of leading horses at the funerals of persons of distinction. Mortuaries, in time, were found oppressive to the yeomanry and poorer inhabitants of parishes: they were regulated, and converted into a money payment by stat. 21 Henry VIII., chap. 6, 1530. Kennett, in the Glossary to his 'Parochial Antiquities,' says that a mortuary was sometimes paid to the lord of a fee, as well as to the priest of the parish.

(Selden, *Hist. of Tythes*, p. 287; Dugd., *Hist. Warw.*, ut supr.; Jacob's *Law Dict.*; Manning and Bray's *Hist. of Surrey*, i., pp. 386, 388; Kennett's *Paroch. Antiq.*, i., p. 101, and *Glossar.*)

MOSAIC, a description of inlaid work by which a design is produced on a surface by joining together small pieces of differently coloured substances.

Mosaic work is of great antiquity. By most authorities it is believed to have had its origin in Asia. The "pavement of red, and blue, and white, and black marble," or "of porphyry and marble, and alabaster, and stone of blue colour," in the court of the garden of King Ahasuerus (Esther, i. 6), was no doubt a pavement of mosaic work. In Greece, inlaid pavements of variously coloured marble were among the sumptuous decorations of the time of Alexander. They were for the most part probably of fret-work or geometric patterns; but among the earliest mentioned by Pliny ('Nat. Hist.' xxxvi. 60) are those *lithostrota* formed of coloured tesseræ, the work of Sosos of Pergamos, whose masterpiece was the 'Unswept Hall,' a representation of the crumbs and fragments which would be found on a floor after a banquet; together with a cantharus or two-handled vase from which a dove was drinking, while others were pluming themselves and basking in the sun. By the 3rd century B.C. the art had so far advanced, that, according to Athenæus (v. 40–47), floors were laid down in the great ship of Hieron II., which were composed of small cubes of stone of every colour, so as to represent the entire history of the siege of Troy: a work, the execution of which occupied 300 workmen an entire year.

From Greece the art was carried by Greek workmen to Rome, where it was known as *Opus musivum*, and acquired universal favour; and soon came to be applied not only to floors but to walls and ceilings. Pliny and others have left tolerably full particulars of the kinds of mosaic practised at Rome, and of the mode of working; and many specimens have come down to us. The most common kind was that composed of cubes of different coloured stones, or earthenware cemented together so as to form a regular pattern, and used for pavements. This was called *Opus tessellatum*, from the tessellæ, or tesseræ, of which it was formed. Pavements of this description are found wherever the Romans settled, no less than in Rome itself—in Asia Minor, Spain, Gaul, and England, and not only in cities or large towns, as in Carthage or London, but in the remotest villages and way-side villas. Scarcely a house of any size in Pompeii appears to have been without its mosaic pavements. Specimens of these Roman tessellated pavements are to be seen in most national and local museums: the British Museum possesses several which have been found in London and various parts of England. There is, as may be supposed, a wide difference in the artistic taste and technical skill of these specimens, but their general character is the same. They consist usually of a central piece—frequently of huma beings or animals—with a border or frame of a regular pattern. N attempt is made to produce refined gradations of colour or tone, or effects of light and shade; nor does it appear that the junctions of the tesseræ were sought to be concealed. The whole treatment of these Roman pavements is large and simple; the work is decorative work, i fact, not meant to be inspected minutely. *Fig.* 1 represents a fine pavement of this description found within the cella of a small temple of Venus at Pompeii. A more elaborate and very costly description, the true *pictura de musivo*, was that known as *Opus Vermiculatum*, which, like the mosaics of modern Italy, was composed of extrem small cubes o marble, coloured stones, clay, or glass, and in whi the musivarii (as the workers in the finer mosaic were call endeavoured to approach as near as possible to the appearance o

Fig. 1.

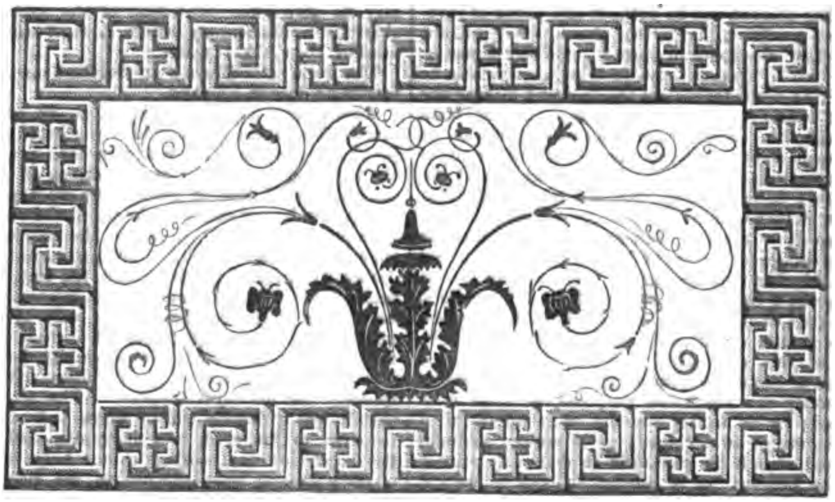
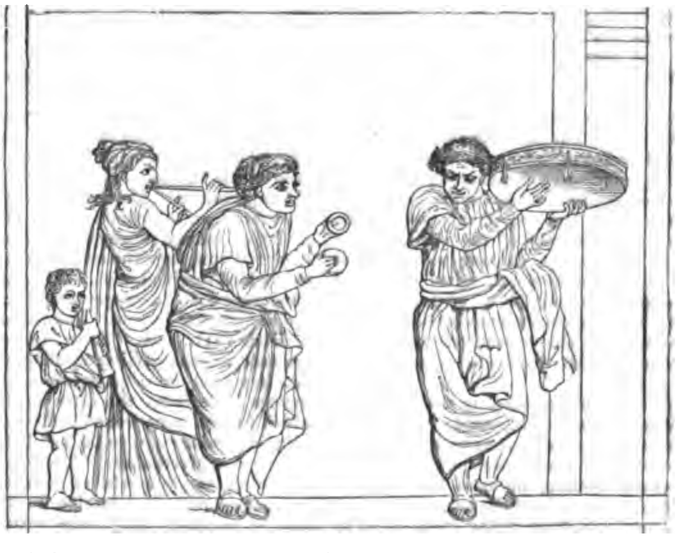


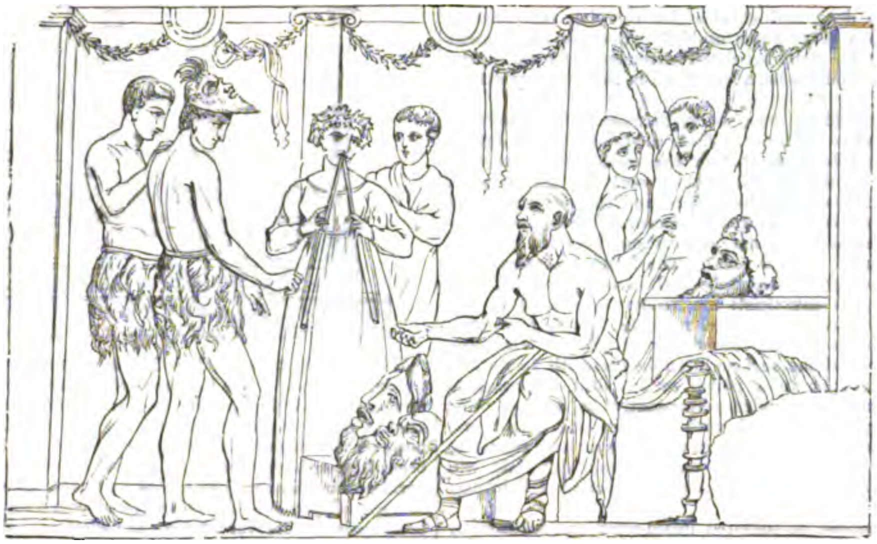
Fig. 2.



painting. The immense difficulty of this kind of painting, as it is sometimes called, will be understood when it is recollected that every degree of light and shadow, and all the gradations of colour, must be produced, not as in painting proper, by the modification or superposition of hues and tints, but by the juxtaposition of solid pieces in stone or glass; and that, consequently, these must be sometimes of an exceedingly small size, and selected and united with the utmo delicacy and accuracy. Of this kind of mosaic several very beauti examples have been discovered. One of the most celebrated is the now known as 'The Doves of the Capitol,' which was found, wi some other mosaics of great value, in the villa of Hadrian at Tiv and which appears to be a copy or imitation of the Cantharus an

Doves described by Pliny as the chief work of Sosos. Cardinal Furietti, who first described this work, counted 160 cubes of marble in one square inch. It was secured for the Capitol by Clement XIII. No less famous are the mosaics of the 'Rape of Europa,' found at Preneste, and now in the Barbarini Palace at Rome; and that of 'Hercules delivering Hesione,' found near Arpino, and now in the Villa Albani at Naples. Some exquisite examples of this class of mosaics have been found at Pompeii; among others, the noblest yet known, a large piece consisting of many equestrian and other figures, representing, as is supposed, the 'Battle of Issus,' and which is composed of innumerable small cubes of glass. It is one of the most admirably designed examples of Græco-Roman art extant, but the execution is not equal to the design. It was found in 1831 in the Casa del Fauno, and is now in the Royal Museum of Naples. Another very celebrated example was found in April, 1762, in the house known as the Villa of Cicero; it represents four masked figures playing on various instruments and dancing, and bears the name of the artist Dioscorides of Samos. (*Fig.* 2.) Of more exquisite workmanship—and in all respects a fine example of Græco-Roman art—is a mosaic representing a Choragus, or Master of the Chorus, instructing his actors in their parts, which was found in what was called from it the House of the Choragus at Pompeii. (*Fig.* 3.)

Fig. 3.



Another description of mosaic work in vogue among the Romans was that called *Opus sectile*, which consisted of larger pieces of coloured marble very carefully fitted together into pictures of a simple kind, something like what is now practised under the name of Florentine work: this is sometimes called *Opus Alexandrinum*, from having been first introduced by, or in the reign of, Alexandrinus Severus. Another kind, again, was executed in wood, and known as *segmentatum*.

On the decline of the Western Empire, this, like the other arts, was practised principally in Constantinople, where a school of workers in mosaic was formed, which for many centuries furnished artists for Italy, and through Italy for the rest of Europe: and, until the revival of art, mosaic was the usual method adopted for mural decoration in the churches of Italy. The Byzantine type of Christian mosaic dates from the 4th century, and continues down to the 12th, when it began to be superseded by a native Italian style. The walls and vaulted ceilings as well as the pavements of several of the basilicas in Rome and its vicinity are decorated with Byzantine mosaics of the 4th and 5th centuries. One of the best known of these is that of Santa Maria Maggiore, but the mosaics have been much repaired. An older mosaic is the representation of Christ and two Apostles, in the church of Sta. Constantia, erected by the Emperor Constantine. Some remains of the Roman school, however, seem to have lingered on, and the Christ in the church of SS. Cosmo and Damiano, of the 6th century, is believed to be quite free from Byzantine influence. Later, however, this influence was paramount, and extended even to England. Churches now mostly had in their apses a huge mosaic of Christ, his hand resting on a book, either above or surrounded by his apostles, technically called a Majesty. Some of the best examples of these are in the churches of Ravenna; but the same uncouth, expressionless, conventional type is apparent in all. By the 8th century, Byzantine mosaic had degenerated into mere rigid manufacture, carried on by fixed monastic rules, and it did not revive till the time of the Comneni in the 12th century, and then soon to relapse into its previous state. Some of the Byzantine mosaics, however, of this date have a certain splendour of effect from being of large size, and executed in vivid colours on a gold ground. The tesseræ of which the Byzantine mosaics are formed, are very irregular in size, and the workmanship is often extremely coarse. Many of these Byzantine mosaics are remarkable for their large amount of Orientalism of character. Among the rich examples in the cathedral of Monreale, near Palermo, in the church of San Miniato of Florence, and elsewhere, are patterns almost exactly like those found in Saracenic tracery.

One of the most remarkable mosaic works in Italy consists of the decorations, external as well as internal, of the church of St. Mark at Venice, which extend in all over some thousands of square feet of surface. For this great undertaking a very large number of Byzantine workmen were in the 11th century brought from Constantinople; and even some of the mosaics were, it is said, imported also. But native art was beginning at this time to revive in Italy, and this and other great undertakings no doubt acted as a strong stimulus to native genius. In the 13th century, Andrea Tafi, Gaddo Gaddi, and even Cimabue and Giotto, designed mosaics, and in a newer and nobler style than the people had been accustomed to see. Italian musaicisti began to be employed upon the works of St. Mark, which were, with all the wealth of Venice, prolonged over several centuries; and eventually a native school was formed, which carried the art to its utmost perfection, so that, as Vasari observed, "it would be impossible to accomplish greater things with colours." Indeed, as Lanzi remarks, "The church of St. Mark remains an invaluable museum, where, commencing with the 11th century, we may trace the gradual progress of design belonging to each age up to the present, as exhibited in many works in mosaic, beginning from the Greeks and continued by the Italians."

Mosaic was in its most flourishing condition in the 16th century, when the Byzantine had come to be throughout Italy, with the exception perhaps of Naples, superseded by a native school. At this time the most distinguished painters—as Titian and Veronese in Venice, and Raffaelle in Rome—did not disdain to make designs for execution in mosaic. But it soon after declined from its pre-eminence. Before fresco painting, in the hands of the great masters who practised it, mosaic was compelled to give way; and though it found ample patronage from the popes for the decoration of St. Peter's—the most marvellous work executed in mosaic subsequent to St. Mark's,—and has continued to be prosecuted with continued success down to the present time, it has long been employed mainly in producing copies of pictures, and not in embodying original design.

Mosaics of this kind came into vogue in the 17th century, when, in consequence of some of the frescoes of Raffaelle, Da Vinci, and other great painters, having already decayed from being painted on damp walls, it was desired to have comparatively imperishable copies of them; and this kind of work is that now almost exclusively practised. In the Vatican there is a workshop devoted exclusively to preparing the mosaics of St. Peter's, and a similar establishment is maintained in connection with the cathedral of Monreale in Sicily. Mosaics of this kind are facsimiles of the original pictures, and have merely the effect of paintings produced in the usual way, although beyond all comparison more laborious and tedious in their process, and necessarily, from the nature of the process, lacking their freedom and play of hand. As each separate piece of glass is of the same colour throughout, the graduation of tints, the melting off of any one colour from its highest light to its darkest shadow, can be obtained only by an immense number of small pieces, of which those contiguous to each other exhibit scarcely any perceptible difference to the eye. It has been said that no fewer than ten thousand different tints, all of which must be kept methodically sorted and arranged, are requisite for this kind of mosaic-work; the preparation of such a palette therefore, for anything upon an extensive scale, must of itself be a task of great labour and time, as well as expense; besides which the execution is so entirely mechanical, that it is fit only for copyists. Some of the larger and more elaborate works are said to take fifteen or twenty years in copying. The sole advantage in any degree proportionate to the cost attending it, is the extreme durability of the work when once accomplished, as its colours can hardly be changed by any length of time; nor is it liable to decay or injury, except what may happen to the structure in which it is fixed. The mosaics in St. Peter's, which are masterpieces of their kind, may be expected to last as long as the building itself stands. When Sir Christopher Wren designed St. Paul's it was his earnest wish to have the cupola decorated with mosaics, like the cupola of St. Peter's, and he had actually entered into negotiations with some Italian musaicisti for their execution, but the authorities would not give their sanction. Quite recently proposals have been issued by the present dean and chapter for carrying out Wren's intentions, according to a plan drawn up by Mr. Penrose, the present architect to the cathedral. Many tesselated pavements of good design and excellent workmanship have been laid down in this country within the last few years.

The modern Italian musaicisti have reached almost the perfection of technical and manipulative dexterity. Their mode of working differs, however, little in principle from that of the mediæval workers in mosaic. They employ for the ground of their work a plate of metal or a slab of travertine, the size of the picture, and this is surrounded by an iron frame. In this bed is spread a cement or stucco, composed of mastic, powdered travertine, and carbonate of lime, mixed with linseed oil, so as to form a paste. The tesseræ, or smalti, of which the picture is composed, are imbedded in the cement, which is only laid as far as the musaicisti are ready to proceed at one time, as it remains but a short period in a fit state for working on, and eventually hardens to the consistency of stone. When the whole picture is completed the surface is rubbed smooth to remove all inequalities, and brought to a polish, or left dull, according to the position the picture is intended permanently to occupy. The smalti are of opaque glass, coloured with metallic oxides and prepared in a peculiar manner. They vary in size from an inch square to a pin's head. The mediæval mode of working and materials, will be found described in Mrs. Merrifield's 'Ancient Practice of Painting,' v. i., p. lii. &c.

Something akin to mosaic or coloured inlaid-work was occasionally employed in Italy during the middle ages for external decoration also; as an instance of which the façade of the Duomo at Pisa may be mentioned, where, though the pattern is chiefly in black and white, brilliant reds and blues are intermixed at intervals, a species of external decoration supposed by some to have been derived from the practice of *polychromy* among the Greeks. [POLYCHROMY.] This is much the character of the Oriental mosaic, of which the mosques of Cairo and Damascus afford very beautiful examples. On the resemblance between Oriental and Byzantine mosaic work, and the characteristics of the former, see 'Hessemer's Arabische und Alt-Italienische Bau-Verzierungen.'

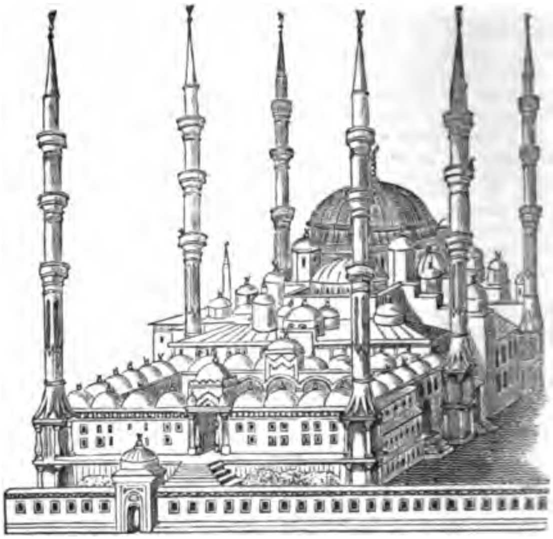
Pietra Dura, or Florentine work, is a kind of mosaic, in which by pieces of coloured stones and marbles, figures or patterns are formed on marble slabs for tables and decorative purposes. An imitation of it is manufactured to some extent with Derbyshire marbles at Matlock, Derby, and Buxton. There is a fine sort of Florentine work, called in Italy, Pietra Commesse, which is executed with agates, jasper, and other precious stones, cut into various shapes and sizes; it is an elegant but very costly style of ornamentation.

What was called *Tarsia work*, or *Tarsiatura*, was a kind of mosaic in wood, by which landscapes and patterns were inlaid in walnut panels, by means of small pieces of wood of various shades and colours. A very humble imitation of it is the inlaid toy-work known as Tunbridge-ware.

(Furietti, *De Musivis Romæ* (1752); Ciampini, *Vetera Monimenta;* Mazois, *Les Ruines de Pompéi;* Donaldson, *Pompeii;* Laborde, *Mos. d'Italica;* Müller, *Handbuch der Archäologie;* and *Archäol. der Alten Kunst;* D'Agincourt, *Hist. de l'Art*, tab. 18, &c.; Merrifield, *Ancient Practice of Painting*, vol. i.; M. D. Wyatt, *Specimens of the Geometrical Mosaic of the Middle Ages;* Secchi, *Musaico Antoniano descritto e Illustrato;* Kreutz, *La Basilica di San Marco in Venezia, esposta ne suoi Mosaici;* Gruner, *The Mosaics of the Cupola, in the 'Cappella Chigiani' of Sta. Maria del Popolo in Rome,* designed by Raffaello Sanzio d'Urbino.)

MOSAIC GOLD. [TIN, *Bisulphide of.*]

MOSQUE (from the Arabic *Maschiad* or *Medsched*, and intermediately the Spanish and Portuguese *Mezquita* and *Masqueta*), a Mohammedan place of worship, the distinctive marks of which are generally cupolas and minarets. [SARACENIC ARCHITECTURE.] Internally the mosques exhibit nothing remarkable as to plan or accommodation, forming merely a single large hall or apartment, without any seats or other fittings-up, and with no other decoration than that of pavements and carpets, or arabesques and mosaics on the walls. In regard to these latter, some of the mosques at Cairo are highly embellished. Although more famed than any other, the mosque of Santa Sophia at Constantinople exhibits nothing of Mohammedan or Arabian architecture, but was originally built as a church, and is in the Byzantine style. [BYZANTINE ARCHITECTURE.] The mosque of the Sultan Achmet, called the At-Meidan, at Constantinople, though of much later date, shows the influence of the Byzantine model: we give an engraving of it as an excellent example of a Turkish mosque.



MOTET (*Mottetto*, Ital.), in Music, a vocal composition set to sacred words, and used in the Roman Catholic church. The word was synonymous with anthem, when first introduced, and signified a superior kind of hymn, accompanied only by the organ. [ANTHEM.] Latterly however the Motet has lost much of its primitive solemnity, having been, for considerably more than half a century, written with full and florid orchestral accompaniments, and thus, like the Mass, is deprived of no small portion of its devotional character. Many attempts have been made to discover whence the word is derived, but without any satisfactory result.

MOTHER-LIQUOR. [MOTHER-WATER.]

MOTHER-WATER. When any saline solution has been evaporated so as to deposit crystals on cooling, the remaining solution is termed the mother-water, or mother-liquor, or sometimes merely the mothers.

MOTION is change of place; there has been motion when a body, at one time, occupies a part of space different from that in which it was at a preceding time. The only additional necessary conception is continuity of change: every point which has moved from one point of space to another must have passed over every part of some line, straight or not straight, drawn from one point to the other.

Some of the ancients used the word in a more general sense, answering to change. Thus, according to them, creation, generation, corruption, increase, diminution, and change of place, are the six sorts of motion. We have here no further to do with this than to remind our readers, when they see *local* motion spoken of in old writings, that this is the term by which simple change of place, to which the word motion is now restricted, is distinguished from the other changes which the same word then denoted. We still apply the word, as we do terms of magnitude (see that word) to changes of the moral system, as in speaking of the motions and emotions of the mind.

If there be anything which would need neither definition nor comment, it might be supposed to be simple motion, a thing never absent from one moment of the waking perceptions, nor even of the dream. Its existence was however denied, or is reported to have been denied, by various of the Greek sophists, though it is highly probable that some matter-of-fact historians have handed down as a deliberate opinion what was merely meant for an ingenious attack on one or another established school. According to Sextus Empiricus (i. § 17), Diodorus surnamed Cronus, a Carian, disproved the existence of motion as follows:—If matter moves, it is either in the place in which it is, or the place in which it is not; but it cannot move in the place in which it is, and certainly not in the place in which it is not: consequently it cannot move at all. To which the first named author replies, that by the same rule men never die, for if a man die, it must either be at a time when he is alive, or at a time when he is not alive. A better answer would have been, that it is true of all material phenomena that they happen either in the place in which the matter is, or in that in which it is not, except only the change from that place in which the matter is and will not be, to that in which it is not but will be. The syllogism of Diodorus may be useful to remind us that motion implies both spaces and times, since the sophism excludes the latter from consideration. Zeno of Elea (not the Stoic) gave the celebrated argument of Achilles and the Tortoise. [PROGRESSION.]

If we consider merely motion, without any reference to the matter moved or the quantity of external force required to move it, we have, as we conceive, a subject of pure mathematics before us, though this has been contested. Newton however used considerations of motion without hesitation in his fluxions; and his successors have endeavoured to avoid them by circumlocutions, which, however consonant they may be to conventional ideas of rigour, have never failed to introduce perplexity and obscurity to the beginner. It may be right to remind the student that the change of place introduced by Euclid (i., prop. 4 and other propositions) has not necessarily all the concomitants of the idea of motion; geometry would not interfere to prevent the superposition from being made without the notion of the triangle, whose place is changed, passing through the intervening parts of space. It was the introduction of the idea of *time* which the parties who objected to the doctrine of fluxions repugned.

But if we consider matter in motion, we must inquire into the external causes of motion, and the capabilities of matter with respect to motion; this we shall do in the next article [MOTION, LAWS OF], confining ourselves in the present one to the first-mentioned branch of the subject.

Next to the idea of motion comes that of swiftness, rate of motion, or velocity (see also the latter word), suggested by observing different motions, or different changes of place in the same time. But here we must observe, that we are rather indebted to motion for our measure of time than to time for our measure of motion. If sentient beings, like ourselves, had lived in perpetual day, without any recurrence of periodical phenomena in nature, or any mechanical means of generating equable motion, we have no right to suppose that they would ever have learned to consider time as a measurable magnitude. They might admit that it might be more or less, as we do of industry, courage, or any other moral qualities [MAGNITUDE], but we cannot be more destitute of measures for those qualities, than they would be of means for measuring time. Since however we have obtained, though by means of equable motion, a distinct idea of successions of duration, equal in magnitude, we use this idea in the definition of motion, just as in geometry we consider the line before the surface, though we have no certainty that we ever should have a distinct notion of a line, if we had not formed lines by the intersection of surfaces. We say, though we have no certainty, but we do not forget that many philosophers are of opinion that such ideas as those of time and of a line are fundamental notions, resulting from our rational organisation, and (if we do not mistake them) anterior to observation, or, at least, not derived from it. This question is here immaterial, as we suppose all parties ready to start with a definite notion of time. Considering the motion of a simple point, which describes a line, it is called uniform when the lengths described in successive equal times are equal, *whatever each time may be.* It is important to remember this, since different successive motions may be uniform in some respects and not in all. Thus successive revolutions may be performed in equal times, as to whole revolutions, but equal fractions of one revolution may not be performed in equal times. In uniform motion, an arbitrary unit of time is chosen, and the length described in that time is called the *velocity,* which is simply the Latin for *quickness.* If extreme verbal correctness were required, this length should be called, not the velocity or swiftness, but the measure of the velocity. For the length described in (say) one second is not the velocity or swiftness, but something by which we judge of it. The word velocity is an abstraction from the comparison of motions; of two moving points, that one which described the greater length in a given time moved the quicker: and swiftness is the absolute substantive by which we express the existence of the obvious relation, just as magnitude is that by which we express the existence of the relation of greater and less.

When equal spaces are not described in equal times, we can imagine the rate of motion to change either gradually or discontinuously. Thus it can be imagined that a body which moves for some seconds uniformly at the rate of 10 feet in a second, may at once, without any intermediate state, take a velocity of 20 feet. But such a conception cannot be realised on any material body, though there may be all the appearance of it. [IMPULSE.] When the rate of motion is changing perfectly gradually, there seems to be no direct method of obtaining the rate at any one instant; for no successive equal spaces are described in equal times. This difficulty will be discussed in the article VELOCITY: for the present, it may be considered sufficient to take a length so small that the change of rate undergone in passing through it is insensible, and to consider the point as moving uniformly through that length. Let the very small portion of a foot represented by δs be described in the small fraction of a second, represented by δt. Let v be the number of feet which would be described in one second, at the same rate. Then, $v : \delta s = 1 : \delta t \therefore v = \frac{\delta s}{\delta t}$; and δs and δt being taken as small as we please, $\frac{\delta s}{\delta t}$ may be taken for the velocity at any instant.

The existence of motion is detected either by a change of the distance of an object, or of its direction, or both; but it is not necessarily the object which moves. The spectator himself may be in motion unconsciously, and it is matter of common experiment that every motion of the spectator of which he is not conscious, and every rapid motion, whether he be conscious of it or not, causes surrounding objects to appear in motion. In walking, the effort necessary to maintain motion perpetually reminds us that it is ourselves who move; in a carriage, at an ordinary pace, we can always destroy the illusion of surrounding motions by a moment's thought. But if the attention drop, and we look at objects with the mind intent on other things, they soon take the motion of the carriage in a contrary direction. In the smooth motion of a boat, no effort of thought will enable the spectator to realise his own motion, and destroy that of the shore or a neighbouring vessel. We state that which we find to happen to ourselves; perhaps the experience of other persons may be different.

It may also happen that the object is in motion as well as the spectator, in which case the latter motion will be transferred to the former, in the manner in which we shall describe. The whole motion of the object, compounded of that which it has of its own, and that which it appears to have from the motion of the spectator, is called the *apparent* or *relative* motion.

The method of ascertaining the relative motion is as follows:—Since we only determine the positions of bodies by their distances and directions, and since we suppose the motions both of the spectator and the object to be given, let a fixed point be taken to represent the position in which the spectator imagines himself to remain, and, laying down the real distances and directions of the object at the end of successive times, set off those distances from the fixed point in the proper directions. The relative positions of the object being thus secured, the line passing through these positions will be that in which the object appears to move. For instance, let the spectator move through 1 2 3 . . . 8 9 while the object moves through A B C . . . H I, so that when the first is at 1, the second is at A; when the first is at 2, the second is at B, and so on, the last positions being 9 and I. Take O for a fixed point, at which the spectator fancies himself to be, and having joined 1 and A, 2 and B, &c., draw O *a* parallel and equal to 1 A, O *b* parallel and equal to 2 B, &c., and O *i* parallel and equal to 9 I. Hence the spectator, fixed at O, will see the object successively at the same distances and in the same directions as *a*, *b*, &c., and *i*; whence the line *a b c . . . h i* will be that of its apparent motion.

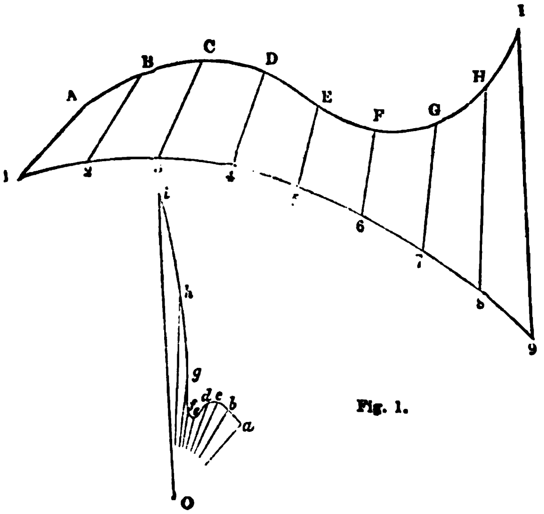
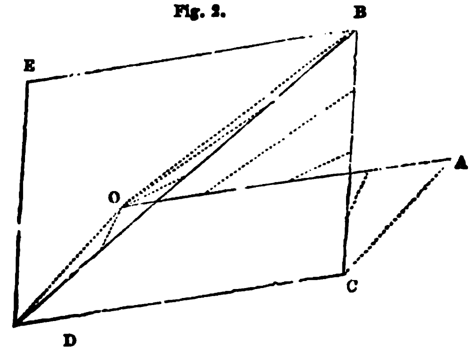


Fig. 1.

When both motions are rectilinear and uniform, the apparent motion may be more simply obtained, as follows:—Let the spectator move uniformly from O to A, while, in the same time, the object moves from B to C. Take the following method of fixing the spectator:—As he moves forward from O to A, let the paper on which the figure is drawn move backward in the direction contrary to O A, so that by the time the spectator has reached A, the point A shall have receded to where O was. He will therefore never have changed his place, his progression on the paper having been always compensated by the retrogression of the paper itself. Take C D parallel and equal to A O, whence the point C will, by the motion of the paper, be at the end of the motion, where D was at its beginning. Consequently, the spectator, who imagines himself at rest, will give to B that motion which is compounded of a

Fig. 2.



is, B will appear to move along the line B D, the spectator imagining himself to remain at O. The dotted lines show the method of proceeding, as first described.

While a ship A (*fig.* 3) moves from A to B, let C move through C D

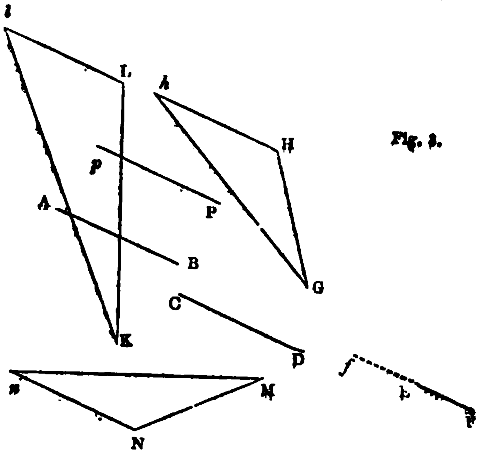


Fig. 3.

(C D being equal and parallel to A B), E through E F (E F being parallel to and equal to one-half of A B), G through G H, K through K L, M through M N, and let P remain at rest. Then, a spectator in A supposing himself at rest, C will appear to remain at C, E will appear to move through E *f*, G through G *h*, K through K *l*, M through M *n*, and P through P *p*. The motion of A has been transferred in a contrary direction to each of the other vessels.

When bodies are very distant their changes of distance are not soon perceived, consequently it is only by change of direction that their motion becomes visible. This is the case in all the heavenly bodies; but we shall now show what the apparent motion of a planet, superior and inferior, would be, if changes of distance, as well as direction, could be perceived and estimated.

If the spectator be in motion, an object at rest appears to him to have precisely his own motion, but in a contrary direction; for if the object be O and the spectator move through A B C D, no distances would be changed if the spectator were fixed at O, and the object moved through A B C D, and all directions would only undergo a diametrical change. Consequently the relative motion of the object is represented by allowing it to change places with the spectator, and inverting the direction of north and south, which will have the effect of making the relative motion from west to east, if that of the spectator were from east to west, and *vice versâ*. Let us suppose now that the earth moves round the sun in a circle, which will be near enough for our present purpose; it will be immediately obvious that the direction of motion, so far as concerns the order in which constellations will be described, is the same in the relative motion of the sun round the earth as in the absolute motion of the earth round the sun. For though the absolute directions of motions are opposite, yet S, to a spectator at E, is seen towards a point of the heavens opposite to that in which E appears from S. [Motion, Direction of.]

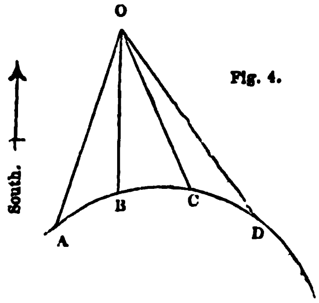


Fig. 4.

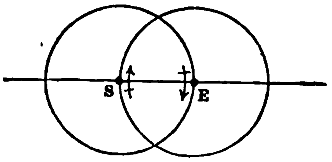
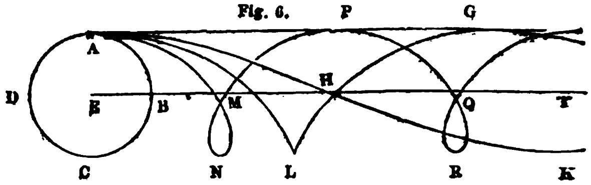


Fig. 5.

In giving to the sun the apparent motion which answers to the real motion of the earth, the same motion must be given to the orbits in which the planets are carried round the sun. The question then is as follows:—If a planet move round the sun, say with a uniform circular circularly, what path will the planet actually trace out?

To get a notion of the possible species of curves, let us simplify the question by supposing a circle A B C D moving along a straight line E T while a point moves round the circle from A.

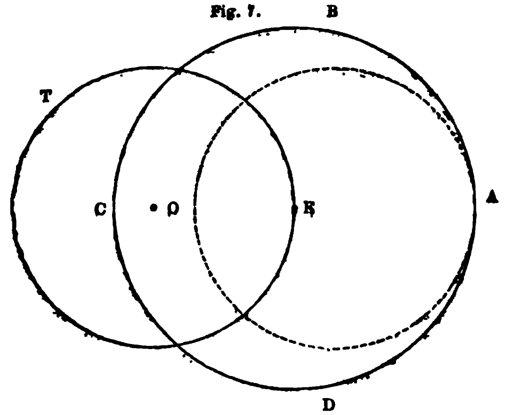
Fig. 6.



In the first place, it A did not move round at all, the line A G would be described; if A moved slowly round, the translation of the circle would cause an undulating curve like A H K to be described; if A moved as fast on the circle as the circle itself is moved forward, the undulation would be changed into a curve with cusps like A L G; while if A move faster on the circle than the circle is carried forward, the circle, so to speak, will not have time to get out of the way, and prevent the formation of loops, as in A M N M P Q R Q.... The faster A moves, the larger and the nearer will be the loops, so that at length no one will be clear of the preceding and following, or the loops will interlace.

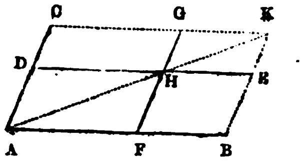
If the circle move round another circle, the same appearances will be presented in an inverse order. Let the centre E of the circle A B C D (*fig.* 7) be carried round the circle E T, whose centre is O. If A did not move at all upon its circle, it would, by the motion of its circle, describe a circle (dotted) equal to E T; if A moved slowly, it would describe a succession of close loops enveloping O; if quicker, the loops would at last disengage themselves from each other; while for still more rapid motion of A the loops would become cusps, and afterwards the curve would simply undulate. The character of these curves will be further discussed under Trochoidal Curves, and their astronomical application under Planetary Motions. It is sufficient here to say that the apparent orbits of all the planets (or rather, the orbits as they would be if changes of distance were perceptible) are trochoidal curves of the above-described species, with loops which do not interfere with one another.

Fig. 7.



The composition of motion has been virtually proved in the preceding paragraphs, combined with the account of the second law of motion. [Motion, Laws of.] If causes of motion act instantaneously, one of which would make a body describe A B (*fig.* 8) uniformly, and the other A C, *in the same time*, we find in the second law of motion that the body will move so that its distance from A B at the end of any time, measured parallel to A C, is what it would have been if the cause of motion in the direction A B had never existed nor acted. Suppose, for example, that three-fifths of the whole time of motion from A to B has elapsed; take A D three-fifths of C, and the body must be then somewhere in the line D E. Again, take A F three-fifths of A B, and by the same law it follows that the body must be in the line F G,—that is, it must be at the point H, which simple geometry shows to be on the diagonal A K, and by three-fifths of that diagonal distant from A. The same may be shown for any other proportion of the whole time; consequently the body, impressed with the two motions, describes the diagonal A K uniformly, and in the same time as that in which the separate motions,

Fig. 8.

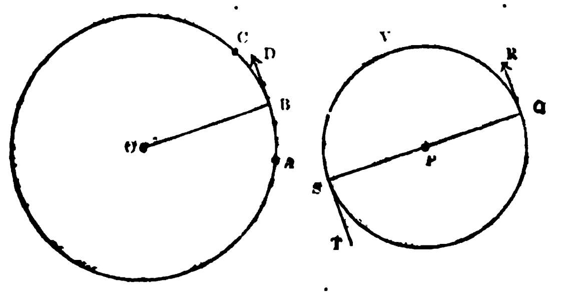


from A to B, or from A to C, would have been performed. This is precisely the course the body would have taken in space, if, while it moved from A to B on the paper, the paper itself had taken the motion A C; but the establishment of the latter assertion must not be confounded with the proof of the composition of velocities impressed on matter; the latter requires those considerations which lead to the second law of motion.

There are a great many uses of the word "motion," which are convenient, but require the introduction of arbitrary suppositions. Thus the moon never cuts the ecliptic twice running in the same place, and the intersection of her orbit with the ecliptic being called a node, it is said that the *node moves*, thus giving this node a sort of imaginary existence in the interval.

MOTION, APPARENT. [Motion.]

MOTION, DIRECTION OF. We have inserted this article, not for the sake of rectilinear, but of circular motion, the consideration of which is apt to cause some embarrassment to the beginner. In motion along a given right line there can be but two directions, in one or other of which the course must be; and these two directions are opposite to one another. But in circular or other rotatory motion, all imaginable directions are taken in the course of a revolution, and whatever linear direction the moving body takes at any one point, it has the opposite direction at the opposite point. Still, however, there are two ways of moving on a circle: the motion may either be from C to A through B, or from A to C through B. These are called, somewhat improperly, different directions of motion.



If two bodies be moving over two circles, they are said to move in the same direction when, two radii being taken in the same direction, the linear directions of motion are the same, as B D and Q R. Thus care must be taken not to compare two circular motions by positions which belong to radii in opposite directions. If, for instance, the directions of motion be A B C and Q V S (which are the same), and if at the same time the two bodies be at B and S, their linear directions of motion are opposite, though according to the definition their circular motions are in the same direction. Thus, in the case of the moon, and her revolution round her own axis [Moon], the middle point of the visible moon is moving round the moon's axis in a direction opposite to the orbital motion of the moon; but the radius of that middle point is opposite in direction to the line joining the centres of the earth and moon; so that the direction of revolution of the moon's rotation is the same as that of the orbital rotation.

MOTION, LAWS OF. The laws of motion mean those universal methods of receiving and losing motion which close attention to mechanical phenomena, coupled with strict inductive reasoning, has shown to be inherent in the constitution of matter.

If an intelligent observer, not used to inductive reasoning, nor instructed in the results of mechanics, were required to state the views which experience had taught him of the constitution of matter, as an agent or patient in the production or reception of motion, he would perhaps reply as follows: Matter seems to have no power of moving itself, though if we judge from the fall of bodies towards the earth, the phenomena of magnetism, &c., it would appear as if matter might be the cause of motion in other matter. And it seems moreover that motion is an accident of matter which diminishes and dies out of itself, if some sustaining cause be not perpetually in action; for in all cases in which the experiment can be tried, we find that moving bodies are reduced to rest by being left to themselves. The motions of the heavenly bodies, it is true, appear to be permanent; but we have no certain assurance that there is not a constant sustaining *physical* cause of this permanency.

There would be something of truth, and a good deal of falsehood, in the preceding conclusions, and it is not an easy thing to give that exhibition of the real constitution of matter which is placed beyond all doubt by the coincidence of its results with all the more complicated phenomena of nature. There is no question that those principles, to take two cases out of thousands, on which a ball can be projected almost unerringly to its mark from the mouth of a cannon, and the motions of the moon can be predicted within a small fraction of a second, are founded in truth; but it does not therefore follow that an *à priori* demonstration of them, mathematical or experimental, can be given; and in fact the method of presenting the laws of motion to a beginner is encumbered with serious difficulties.

We shall begin by the assumption that those laws of motion which are to be found in all works on mechanics are true; the reason for such assumption being, that if we take them for granted, and use them as the basis of a mathematical system of mechanics, all results of that system, however many the links in the chain of deduction, are found to agree with observed phenomena in species, and as nearly in magnitude as the various resistances and disturbances will allow. In astronomy and optics, phenomena have been predicted with all but geometrical accuracy, by deduction from principles which would certainly be false if the received laws of motion were false. In terrestrial mechanics, the number of instances is unlimited in which these laws lead to that near approximation to prediction which is fully as much as can be expected with our imperfect knowledge of data. Many hundreds of phenomena admit, upon these laws, of an explanation which, compared with that which they could receive from any others, is as easy as the hypothesis of the motion of the earth compared with that of its stability.

So simple are the laws of motion themselves, that many have supposed them to be necessary, in the same sense as when we say it is a necessary consequence of our conception of straightness that two straight lines cannot inclose a space. We shall mention this notion again presently: in the meanwhile we are in this situation, that while it is difficult, as a matter of reasoning, to disentangle the fundamental laws from the variety and complication of the phenomena in which their effects are exhibited, yet these laws themselves, when disengaged, are of that startling simplicity which disinclines the mind to receive them as the results of a train of deduction, and disposes it rather to think that it could have dictated them from its own previous conceptions.

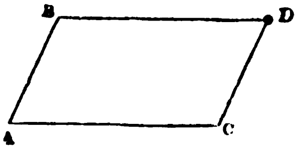
It will make some difference in our method of seeking for these laws, whether we suppose the earth to be at rest or in motion. Now the decisive proofs of the motion of the earth, as it happens, are themselves derived from certain consequences of the laws of motion. [Motion of the Earth.] We seem then to be reasoning in a vicious circle; nor do we see any mode of escape except by establishing the truth of these laws, whether the earth be at rest or in motion. And the process will be, first to detect laws for which there is a high and almost overpowering degree of probability in their favour; next to appeal to the above-mentioned uniform truth of the results deduced from the assumption of such laws for the conversion of this high state of probability into one of absolute demonstration.

We will first assume the motion of the earth: every point of its surface then is in a state of revolution round the axis, while at the same time the whole is carried forward round the sun; to which we must add, the slight motion arising from the precession of the equinoxes, and the possible translation of the whole system. But this motion is very different in different parts; at the pole, for example, there is no diurnal motion, near it only a small one, and at the equator a considerable one. The points near the pole, all the motions considered, are describing a trochoidal orbit, the undulations of which are small, and the rotatory velocity small; those near the equator make larger undulations, with greater velocity of rotation. Our first idea might be, then, that at the different parts of the earth some modification of general laws would be observed, arising from the difference of the motions of the several places. It would not surprise a person wholly unacquainted with mechanics, to whom the preceding facts were stated for the first time, *if he were told* that some mistakes were made in the pointing of guns in our Indian battles, arising from the artillerymen having been trained by officers who had learnt their art in the latitude of Addiscombe, near Croydon, in Surrey, and had forgotten to allow for the difference in the diurnal motion of the two countries. Now the considerations which tend to establish the Second Law of Motion depend upon the fact that it never has been found necessary to take any notice of the difference of place on the earth in estimating effects of motion. It is not found necessary to write different treatises on gunnery for different latitudes, nor to alter the disposition of parts in any machine moved from one latitude to another to produce a more advantageous effect. There is, it is true, a small diminution in the weight of bodies, as they are carried toward the equator, and [Centrifugal Force; Pendulum] the results of this are apparent in experiments in which the acquisition of motion depends upon weight, or rather, upon its proportion to the quantity of matter. But this very problem of the pendulum is one in which the question of the truth of the laws of motion is established by a test which would detect the smallest quantities, and furnishes an answer to those who might say that the possible effects of the difference of diurnal motions, though not distinguishable in such cases as that of a cannon-ball, might be perceptible in delicate instruments.

If to the motion of the earth we superadd another, such as the motion of a carriage, the same sort of result is found. Those who move on a railroad at the rate of 30 miles an hour, or 44 feet in a second, do not find the relation in which they stand to the objects in the carriage in any degree changed by the motion. At the instant of taking the motion, or on any sudden jolt or change of motion, effects may be produced to which we shall frequently refer: but when the speed is once obtained, it is well known that a person might occupy himself in reading a work on mechanics written on *terra firma* (so called), and might verify all the experimental conclusions, without coming to any result which would remind him of the difference of state between the writer and himself, as to motion. Hence we are led to the conclusion that all the relations of matter to matter remain unaltered, if the whole system be made to move, provided that the same motion be communicated to all its parts. And though we do not, absolutely speaking, know what rest is, since no point of the earth, nor of any heavenly body, can be shown to be at rest, yet since we see that the relations remain unaltered when the velocity of a whole system is changed, we are led to conclude that the same laws which prevail when all the parts of a system have the same motion, would also prevail if the whole system were at rest; the ground of our presumption being, that the laws remain unaltered under any alteration of the common motion which it is in our power to make.

Let us now suppose that the carriage, instead of moving in a right line, is carried on a curved road, say a simple circle. It is no longer observed that loose objects in the carriage have a tendency to repose relatively to the carriage itself. If the motion become sufficiently rapid, or the friction of the substances on which they stand be sufficiently small, they will endeavour to move outwards, or from the centre of the circle of motion. This phenomenon can be made a consequence of the laws of motion, when the latter have obtained their simplest form; we do not at present enter into this subject further than to point out that it is only of rectilinear motions we can predicate any law as descriptive of what is inherent in matter. We have, it is true, already spoken of circular motions in taking into account those of the earth; but it must be remembered, firstly, that the circles in question are so large, that a small arc of any one is nearly a straight line; secondly, that we *have* been obliged to advert to this tendency outwards, which is the reason of the diminution of weight (or of much the greater part of it) detected from the oscillations of a pendulum which is carried towards the equator.

This second law of motion (for such it is called, though it must be deduced first when the earth's motion is considered) may be thus stated:—If there be two or more causes of motion, taking place in two different right lines, whether inherent in the body or external to it, their effects do not interfere, nor does either diminish or augment the effect of the other. If, for instance, the body A be subject to two actions, one of which, being entirely in the direction A B, would bring the body to B in a given time, and the other, entirely in the direction A C, would bring it to C in the same given time; then the body will move from A to D, precisely as it would have done if, moving along A B in the manner first specified, the line A B had been translated with its extremity A moving in the second manner specified, the said line A B not changing its direction.



The most simple and general method of stating this law is as follows:—The distance of a point from a straight line or plane, measured in any given direction, and as it will be at the end of a given time, is not affected by the action, during that time, of any causes of motion, provided they act in the direction of, or parallel to, that straight line or plane; or no force, in a given direction, can produce motion to or from a line in that direction. Thus if a ball were thrown up in still air, in such a manner that it would mount 50 feet in one second, no imaginable *horizontal* current or whirlwind, however much it might alter the actual course of the ball, would prevent its rising 50 feet in the second. The statement of the law by Newton, namely, that when a force acts upon a body in motion, the change of motion which it produces is in the direction and proportional to the magnitude of the force which acts, is perhaps rather too vague to give a distinct notion to learners.

From the law just enunciated, we may learn that bodies upon the earth, moving with the earth, have the properties of bodies at rest with respect to all motions that are to be estimated relatively to the earth: at least upon the supposition that the curvature of the motions of the earth is not sufficiently great to produce a sensible effect. We have then to inquire what is the natural state of matter on the earth? Can it preserve any motion of itself, or does every motion gradually slacken and die out, by the mere inability of matter to maintain it without the application of external causes? On this point we have only strong presumptions, which would be by themselves insufficient. Our first step would be to conclude, from what we actually see, that rest is the natural state of matter, and one to which it always approaches, however great a cause of motion be applied, unless that external cause, or some part of it, be maintained. On looking further however we find that terrestrial matter, immediately on its being put in motion, encounters causes of retardation. The resistance of the air, and the friction of the basis on which the substances rest, are easily shown to lessen the motion of bodies which encounter them. The more nearly these are removed, the longer does motion continue. It is certain then that these resistances contribute in a great degree to the destruction of motion; but it is not therefore to be immediately assumed that there is no other cause. If we grant that a perfectly smooth ball, lying upon an indefinitely extended plane without friction, and not in contact with any atmosphere, would move for a long time without any sensible diminution of the rate with which it was made to set out, we grant quite enough to explain all that we see, without the necessity of supposing that the motion would continue for ever. How then can we establish the first law of motion (so called), which is thus stated, that matter will retain its state of rest, or of motion, for any length of time, however great, until acted upon by some external cause? We must here appeal to the results of the application of this law, which has never, in any one instance, exhibited any reason to suspect that it is only approximately true. Throughout the long period of astronomical history, no one of the heavenly bodies has shown any diminution of its motion, or any of the consequences which would arise if the motion had a tendency to wear itself out. We shall not here go into the details of these consequences; the conclusion is, that the state which matter, independently of external bodies, has been created capable of maintaining, is not merely rest, but also uniform motion in a straight line; so that it has no more tendency of itself to part with any of its velocity, nor to move slower or faster than it was first made to move, than it has to set itself from rest into motion. A great many, perhaps most, of the mistakes which have been made by writers against the Newtonian theory of attraction, have arisen from want of proper conception of the *neutral state* of matter. Maintenance of velocity and direction has been to them a proof of the existence of external cause maintained in action; whereas it proves nothing, but that there was at some time or other an external cause which acted for a longer or shorter time: the external cause steps in when the velocity changes, or the direction, or both, and not till then.

Properly considered, the immense number of different states which matter retains, namely, either absolute rest, or any degree of velocity whatsoever, is as wonderful and mysterious a law as that of the attraction of matter upon matter, without any apparent intermediate agent. That matter should, without any perceptible maintainer, keep one rate of motion and one direction until acted on from without, is as difficult to admit, as that the mere presence of other matter should change that motion and that direction. What should teach blind atoms to draw straight lines in preference to circles or spirals? Have they the fundamental conceptions, according to some, or the powers of perception and inference, according to others, by which reasoning minds know or discover the simplicity of a straight line!

These two consequences of observation, namely, the law of its existence, by which matter can retain certain states, if no other matter interfere, and that by which it can change the state of other matter, its own at the same time undergoing another change, should never be allowed to be separated. There are two classes of philosophical speculators (for no religious question need be allowed to enter), whose system introduces no difficulty into the details of mechanical philosophy which did not enter into its principles. The first consists of those theists who look upon the maintenance of the creation to be the consequence of the same power as that which first created, and who consider that one moment's cessation of a sustaining power, of the same quality, so to speak, as the creative, would be the annihilation of all things: the second consists of atheists, who will of course find no more difficulty in the maintenance of the universe than in its first construction. But a great confusion of ideas is introduced into all fundamental questions which relate to matter, by the existence of a sect which we suspect greatly to outnumber either of the former two, and whom we may call believers in the *Creator* and not in the *Maintainer*. These, whatever they may think of the God of the moral world, imagine that the God of the material became inactive and quiescent as soon as matter was created, and endowed with certain powers, or made subject to certain laws. These laws, which are really their minor deities, carry on the business of the universe, and they can abstract the idea of God altogether from the continuance of the existence of matter, though not from its first creation. Among them may be found many of the literal interpreters of the Mosaic account [MOTION OF THE EARTH], who hold strictly that the Creator "rested from his work," and left matter to its "laws," except on certain rare interpositions. Many of this sect have admitted the laws of motion, and, among others, the power of matter to maintain its motion, because there was an appearance of inactive sameness, or want of change, in the permanence of rest, or permanence of direction and velocity. But they have been startled by the entrance of attraction, and have disputed its possibility on account of the absence of *second* causes sufficient for its explanation: however clearly it might be shown that all the results of attraction are present among phenomena, they would not allow their *first* cause to be awakened from the sleep in which it was their pleasure to suppose him plunged, so far as matter was concerned. Perhaps it is one of the most singular mental aberrations which ever was manifested, that at the time of the appearance of the Newtonian doctrine, the first mechanical theory which rested on the *maintainer* of the creation, at least until (which has not yet happened) some good quiescent "second" cause was discovered—that doctrine was frequently charged with atheism.

If the earth were supposed to be fixed, we might obviously (though not obliged to do so) begin from matter at rest, and establish first that law of motion which usually stands first.

The third law of motion was enunciated by Newton as follows:—"Action and reaction are equal and *opposite*." Thus, if a body A exerts a force upon another body B by contact, tension, thrust, attraction, repulsion, or otherwise; then B exerts the very same force on A in the opposite direction. The principle thus laid down belongs as much to statics as to dynamics, and is not therefore to be considered a special law of motion. It seems indeed to establish a relation between the statical and dynamical effects of a force—the action being represented by the pressure employed, the reaction by the motion produced. But how is this motion to be measured? Newton had decided that a body's motion should be measured by its momentum, and enunciated the third law on this supposition. But taking as we now do the velocity generated in a body to be the dynamical measure of the force,—that is, the reaction,—the third law of motion asserts that "the velocity generated in a body by the *action* of a force, whether impulsive or otherwise, is proportional to the force."

Where the force continues to act during a finite interval of time, the body acquires an additional velocity in each succeeding instant—an evident consequence of the second law of motion. The velocity thus generated in a unit of time (as one second) is termed by some modern writers the "rate of acceleration." And this is all that is meant by the expression "accelerating force,"—namely, a force that, acting continually upon a body, produces in it a rate of acceleration. Thus the force of gravity is called an accelerating force, because the motion of a body, under its influence, becomes accelerated; the rate of acceleration being about 32·2 feet per second. [ACCELERATED MOTION.]

Let f and f' denote the rates of acceleration produced respectively by the action of two forces F and F'; then, by the third law of motion, $f : f' = F : F'$. Also, if t be the time during which these forces act, v and v' the respective velocities acquired at the end of time t, we have $v = ft$ and $v' = f't$, hence $v : v' = F : F'$. If a body move under the action of gravitation, the rate of acceleration is $g\ (=32{\cdot}2)$, hence if F act upon a body whose weight is W, we have the following very useful application of the third law of motion:—

$$F : W = f : g$$

or,

$$F : W = v : g.$$

when $v =$ velocity acquired in time t by the action of F.

The three laws of motion, then, may be thus enunciated:—

1. A body, if acted upon by no external force, remains at rest; or if in motion, continues to move uniformly in the same direction.

2. When any number of forces act upon a body in motion, each force produces the same effect in altering the magnitude and direction of the body's velocity, as if it acted singly on the body at rest.

3. The velocity generated in a unit of time by a force continually acting upon a body, is proportional to the force.

The reader will meet with some very clear conceptions of the three laws of motion in Dr. Young's 'Natural Philosophy,' edited by Professor Kelland; also in O'Brien's 'Natural Philosophy,' published by the Society for the Promotion of Christian Knowledge. He may likewise refer to a paper by Dr. Whewell "On the Nature of the Truth of the Laws of Motion." ('Camb. Phil. Trans.' vol. v. part ii.)

The mistakes into which philosophers fell upon the laws of motion are uninteresting except in the applications which were made of them; and in the article MOTION OF THE EARTH will be found enough of these to give an idea of the difficulties which such fallacies placed in the way of sound knowledge. For an account of Galileo's labours, see GALILEI, in BIOG. DIV. For an account of the notions of Descartes on the same subject, see VORTICES. The first distinct enunciation of these laws appears in the Principia of Newton.

Though all mechanical problems admit of solution upon the assumption of these laws, in conjunction with those which may be called the distinctive properties of the solid, fluid, and gaseous states, yet the purposes of mechanical inquiry are better served by certain general principles deduced from them, the proper conception of which can only be made by mathematicians, and are therefore referred to a purely mathematical article—VIRTUAL VELOCITIES. [PRESSURE, FORCE, INERTIA, CENTRIPETAL AND CENTRIFUGAL FORCES, ACCELERATED MOTION, VELOCITY, &c.; MOVING FORCE. See particularly the article INERTIA, for the reason of the non-introduction of that word.]

Among the many absurdities which have arisen out of a misapprehension of the laws of motion, is the attempt to discover what is called a *perpetual motion*, or a machine which of itself would never stop. The earth and planets are such machines in their rotations on their axes; and we have seen that any particle of matter, unacted on by other matter, and once in motion, is a perpetual motion. If a wheel attached to an axle could be deprived of friction at the pivots, and enclosed in a permanently air-tight and perfectly exhausted receiver, it would also, when once in motion, be a perpetual motion. But as long as any friction or resistance, however small, is perpetually retarding the motion, it is obvious that the velocity, if maintained, must be indebted to some external supply of moving power. To take the case of friction, which arises from the roughness of the supports, and which, independently of *adhesion*, may be considered as a rapid succession of very small jolts, by which the roughnesses of the one surface strike upon those of the other, and communicate a portion of momentum to the frame, and finally to the earth: to suppose that a wheel as above described could go on for ever, with friction, would be to suppose that there could be action without reaction. In fact, a perpetual motion, such as is intended to be made by the speculators on the subject, is nothing less than a machine which will work for ever without new moving power; it being not one bit less absurd to suppose that it would perpetually overcome friction and atmospheric resistance, than that it would continue to supply the impetus necessary to carry on the sawing of a plank or the weaving of lace.

MOTION OF THE EARTH. The theory of gravitation has placed this question on a footing entirely different from that on which it was argued, whether by Ptolemaists or Copernicans. Both of the latter parties supposed the existence of a fixed central body somewhere, which the first of them would have to be the earth, and the second the sun. This *centrum mundi*, or centre of the universe, is exploded, and with it all the systems, whether Ptolemaic or Copernican, which preceded the discoveries of Newton. But, as noticed in COPERNICUS, in BIOG. DIV., the existing system preserves the name of that great man; the reason being, that its distinctive peculiarity is retained relatively, if not absolutely, namely, that the planets all move round the sun, or round a point near the sun. But it is added to the real Copernican system, that sun, planets, and all, may be, and probably are, in motion; the translation, as it is called, of the whole system being very nearly rectilinear, and the curvature, if any, arising from the attraction of the fixed stars. Nothing but a long course of observation can settle this last part of the question, though much has been done of late years to establish the affirmative.

In approaching the old controversy on the motion of the earth, we confine ourselves rather to the arguments by which it was opposed than to those by which it was supported. For this we have two reasons: first, that the latter are well known and extensively circulated, while the former, unless preserved in historical articles, will find the oblivion from which they have no intrinsic merit to rescue them; secondly, that the controversies of the present day may be usefully illustrated by recurring to the long-decided struggle between the Copernicans and their opponents. We have now among us those who would fetter all *new* truths by *their* interpretation of the Scriptures, though they quietly acquiesce in the defeat which their own principle formerly received. The charges still brought against the cultivators of the sciences, "to the distress and disgust of every well-constituted mind," as Sir J. Herschel expresses it, should be looked at, not as the honest manifestations of an alarm newly awakened by the circumstances of the present day, but as the effects of an abiding spirit, which has always opposed investigation, and which, if it had prevailed, would have smothered all the knowledge of nature which has been acquired in the last two centuries. If some of those who have constituted themselves successors to the cardinals who forced Galileo to recant, have learnt from the past history of their own cause, and from the temper of the present age, to show the real scope of their system less openly than it appeared in the 17th century, the compliment which they thus pay to the advancing intelligence of mankind, though received with thanks and highly appreciated, should not be accepted as an equivalent for the mischiefs which must result from a successful attempt to place the great question of Revelation upon a false basis. The case of those who now endeavour to impede the progress of geology, or to limit speculation on the *process of creation*, is so similar in its fundamental points with that of the labourers to the same effect in the field of astronomy, that the circulation of some account of the latter will perhaps enable our readers to help themselves in forming their opinion of the former.

When the work of Copernicus appeared in 1543, it seems to have been considered as a mere attempt to demonstrate (see the old use of this word in DEMONSTRATION) the motions of the heavenly bodies in a more simple way. Guarded as it was by the expressions of the preface, it was neglected as a purely speculative trial of a strange and impossible hypothesis. In 1566 Ramus ('Scol. Math.') simply reproaches Copernicus with the gigantic character of his hypothesis, and says it would have been better to have taken one nearer to the truth, in a manner which implies that he thought both were agreed as to what the truth really was. Copernicus himself, as we have seen, treated his own ideas as a reproduction of those of the ancients, and in truth the existence of such a doctrine as the earth's motion was perfectly well known to all men of learning. Aristotle (in his second book on the Heavens) states that Pythagoras and his followers placed the sun in the centre, on account of the superior excellence which they attributed to the element of fire, of which they supposed the sun to be made. Different authorities give the same opinion (whether with or without the reason) to Philolaus, Anaximander, Nicetas, Seleucus, Cleanthes, Leucippus, Ecphantus, Heraclides Ponticus, and Aristarchus. The introduction of Pythagoras, as a predecessor of Copernicus, is as rational as would be the connection of the modern atomic theory with the doctrines of Epicurus; and much of the same kind is an assertion not unfrequently made, that Cardinal Cusa was a supporter of the earth's motion. This writer ('De Doctâ Ignorantiâ,' lib. ii., c. 11) certainly denies that there can be any centre of the universe; for, says he, if there were a centre, there would be a circumference, that is, a termination, to the universe; and his reasons relative to the earth's motion are of the same degree of force. He is more rational in the next chapter, where he explains that the apparent motion of other bodies may be that of the spectator. Riccioli cites a sermon of Cusa, which proves, says he, that the cardinal had come to a sounder opinion; for he speaks of God's angels or intelligences moving the sun and stars. Nothing can better illustrate, in our opinion, the arguments against Riccioli and his predecessors: when the cardinal is writing for men of science, he advances, after his fashion, speculation about the earth's motion; when he is writing *excitations* (not *exercitations*, as Riccioli says) to religious feeling, he speaks of God's works in a manner which persons in general understood; in confounding the preacher of religion with the philosopher, Riccioli made the usual error of his day, and only repeated his own mode of treating Moses, Isaiah, and the writer of Job. But it would have been better to have argued by analogy, that if either of the latter had written a professedly philosophical work, he might, whatever appears to the contrary from his religious writings, have admitted the motion of the earth.

Copernicus had no predecessor as a mathematical reasoner upon the question. The first continental followers of the new system were Rheticus, Reinhold, Mæstlinus the instructor of Kepler, and Urstitius who was probably the instructor of Galileo. In 1556 appeared in England the 'Castle of Knowledge,' by Recorde [RECORDE, ROBERT, in BIOG. DIV.], in which a cautious and implied avowal of Copernican principles is made, and also the Ephemeris of John Field, expressly computed from Copernicus and Reinhold. John Dee and his pupil Thomas Digges (son of Leonard) were both avowed Copernicans: the first absolute defence of the system is contained in the Appendix to the 'Prognostication Everlasting,' &c., of Leonard Digges, republished by Thomas Digges (who added the Appendix) in 1594. This Appendix is called 'A Perfit Description of the Cœlestial Orbes, according to the most ancient Doctrine of the Pythagoreans; lately reuiued by Copernicus, and by Geometricall Demonstrations approued.' We shall quote from this work the account (in modern spelling) of "what reasons moved Aristotle and others that followed him to think the earth to rest immoveable as a centre to the whole world."

"The most effectual reasons that they produce to prove the earth's stability in the middle or lowest part of the world is that of Gravity and Levity. For, of all other, the element of the earth (say they) is most heavy, and all the ponderous things are carried into it, striving (as it were) to sway even down to the inmost part thereof. For the earth being round, into the which all weighty things on every side fall, making right angles on the superficies, pass to the centre, seeing every right line that falleth perpendicularly upon the horison in that place where it toucheth the earth, must needs pass by the centre. And those things that are carried towards that medium," or middle point, "it is likely that there also they would rest. So much therefore the rather shall the earth rest in the middle, and (receiving all things into itself that fall) by his own weight shall be most immoveable. Again, they seek to prove it by reason of motion and his nature; for of one and the same simple body the motion must also be simple, saith Aristotle. Of simple motions there are two kinds, right and circular: right are either up or down; so that every simple motion is either downward toward the centre, or upward from the centre, or circular about the centre. Now unto the earth and water, in respect of their weight, the motion downward is convenient to seek the centre; to air and fire, in regard of their lightness, upward and from the centre. So it is meet to these elements to attribute the right or straight motion, and to the heavens only it is proper circularly about this mean or centre to be turned round. Thus much Aristotle. If therefore (saith Ptolemy of Alexandria) the earth should turn but only by that daily motion, things quite contrary to these should happen. For his motion should be most swift and violent, that in twenty-four hours should let pass the whole circuit of the earth; and those things which, by sudden turning, are stirred, are altogether unmeet to collect, but rather to disperse things united, unless they should by some firm fastening be kept together. And long ere this the earth, being dissolved in pieces, should have been scattered through the heavens, which were a mockery to think of; and much more beasts and all other weights that are loose could not remain unshaken. But also things falling should not light on the places perpendicular under them, neither should they fall directly thereto, the same being violently in the meanwhile carried away. Clouds also and other things hanging in the air should always seem to us to be carried toward the west." In his answer to the preceding, Digges propounds the experiment which was afterwards urged (by those who had not tried it) against Copernicus, as follows: "Of things ascending and descending in respect of the world, we must confess them to have a mixed notion of right and circular, albeit it seem to us right and straight, not otherwise than if, in a ship under sail, a man should softly let a plummet down from the top along by the mast even to the deck: this plummet passing always by the straight mast seemeth also to fall in a right line; but being by discourse of reason weighed, his motion is found mixed of right and circular." From his preface Digges appears to have considered magnetism as the cause of the earth's self-sustaining power; an opinion carried further by Gilbert (the next English Copernican) in 1600, who, in his book on the magnet, endeavours to deduce the earth's motion from magnetic causes, as well as the precession of the equinoxes.

The period from 1543 to 1609, in which the controversy was purely mathematical, has not excited the interest which every one knows to

belong to the consequences of Galileo's discoveries. An account of this period is to be found in the 'Companion to the Almanac' for 1855, in 'Notes on the Ante-Galilean Copernicans.' To this article we must refer the reader for further account, in connection with this subject, of Leonardo Da Vinci, Calcagnini, Widmanstadt, Copernicus, Rheticus, Gassarus, Rheinhold, Ramus, Maurolycus, Bacon, J. B. Benedictus, Tycho Brahé, Rothmann, Stunica or Zuniga, Francis Patricius, Urstitius, Gilbert, E. Wright, Clavius, Vieta, Mæstlinus, Bruno, Ursus Dithmarsus, Maginus, Stevinus, Kepler, Recorde, Field, Digges, Dee, Blagrave, Lydiat, Hume.

Hitherto the theological part of the controversy has not made its appearance. We must date this view of the question from the discoveries of Galileo. Neither in ancient nor modern times have those who would bind over the sciences to agree with *their* interpretation of the Scriptures ever take alarm at hypotheses, until those hypotheses began to have facts in their favour. The inconsistency is worth noting; for, taking these objectors on their own principles, there may be impiety (if the Bible be a revelation of philosophy) in propounding a theory which contradicts it; but there can be none in stating the results which follow from actual investigation: the thoughts of the mind of man may contradict revealed science (if such there be), but the works of the God of nature can hardly detect falsehood in the God of revelation. It was Copernicus, then, and not Galileo, who was the heretic, if heresy there were in the case; but the former and his immediate disciples slept in peace, while the latter was forced to sign a recantation. The story of Galileo is so well known, from the party use which has been made of it amongst us, as well as from the excellent account of Mr. Drinkwater (Bethune) in the 'Library of Useful Knowledge,' that it is unnecessary to go into details. It has been a severe lesson to the Roman Catholic Church to beware of bringing its infallibility to the practical test of a declaration in physics. We say the Roman *Church*, for though admitting that the seven inquisitors who signed the indictment against Galileo are not to be regarded, upon the principles of that Church, as a final authority, yet the sufferance of their decision for two centuries must be construed as the assent[*] of a church which is jealous above all others of what is taught or done by its ministers. The Minims Le Seur and Jacquier knew better than we can do in what state the doctrine of the earth's motion was left[†] by the process; their declaration at the commencement of the third book of their edition of Newton (1742) runs as follows:—"Newton in the third book assumes the hypothesis of the motion of the earth. The propositions of the author cannot be explained otherwise than by making the same hypothesis. Hence we have been *obliged to put on a character not our own*. (Hinc alienam coacti sumus gerere personam.) But we profess obedience to the decrees promulgated by sovereign pontiffs against the motion of the earth." We have sometimes suspected that there is a little sly satire in this last phrase of the worthy fathers. They do not represent the pope as having issued a decree against the *doctrine* of the earth's motion, the phrase one would have expected, but against the *earth's motion*: not *contra doctrinam telluris motæ*, but *contra telluris motum*. At the same time, with reference to the reproaches heaped upon the whole body of Roman Catholics for this persecution of Galileo, we heartily wish that all persecutions, Catholic and Protestant, had been as honest and as mild. There is no reason to doubt the perfect good faith of the whole proceeding; and remembering that the tribunal was one of which Galileo himself admitted the jurisdiction, and supposing the inquisitors to have believed they were doing their duty, any less amount of severity would have been a palpable respect of persons (for Galileo had powerful friends). For ourselves, we would as soon have been among the inquisitors as in the position of Galileo himself, if it be true that, on rising from his knees, after taking the most solemn oaths that he "abjured, cursed, and detested" the doctrine of the motion of the earth, he repeated aside to a friend, "*E pur si muove*" ("It does move for all that"). We may pity, but cannot admire, either party. Not to leave unsaid any palliative on either side, we may state that the exclamation of Galileo has no very good authority, and that the inquisitors themselves were not unanimous. One of them, the Cardinal Bentivoglio, states, in his memoirs, that he did all he could to prevent the decision. It should also be noticed that the prohibitions issued at the time were mostly against works written in Italian; we cannot help suspecting that the opinion would have remained unassailed if it had been expressed only in Latin. The question just discussed was settled June 22, 1633, but this was not the beginning of the controversy. The following list of writings will save future reference; they are headed by their dates:—1614, Scheiner, 'Disqu. Math. de contr. et novitat. Astron.;' 1615, Foscarini, 'Epistola Italica de mobil. terræ.;' 1615, Zuniga, 'Lett. sopra l'opin. del Copernico;' 1616, Cruger,* 'Disput. de quot. telluris revol.;' 1618–1622, Kepler, 'Epit. Astron. Copern.;' 1619, Lansberg (Philip), 'Comm. in motum terræ;' also tracts of Ursinus, Campanella, and Godenius; 1619, Fienus, 'Disp. an Cœlum moveatur et terra quiescat;' 1631, Morinus, 'Famosi et antiqui problematis de telluris motu et quiete hactenus optata solutio;' 1631, Fromondus, 'Antaristarchus, sive Orbis terræ immobilis;' 1633, Galileo, 'Dial. sopra i due massimi sistemi del mondo, Tolemaico e Copernicano,' the prohibited work; 1633, Lansberg (James, son of Philip), 'Apol. comment. Phil. Lansberg in motum terræ;' 1634, Morinus, 'Resp. ad J. Lansberg Apolog.;' 1634, Rosse, 'Confut. opin. Lansbergii;' 1635, Linemann, 'Dsput. math. adstruens mot. diurn. telluri vindicandum esse;' 1638, Wilkins, 'Discourse tending to prove that 'tis probable there may be another habitable world in the moon;' 1638, Bouillaud, 'Philolaus, sive diss. de vero syst. mundi;' 1640, Licetus, 'De terra, unico centro motus, disp.;' 1640 Wilkins (anonymous), 'A Discourse tending to prove that 'tis probable the earth is one of the planets;' 1642, Gassendi, 'Epistolæ duæ de motu impresso a motore translato;' tracts of Deusingius, Morinus, and others; 1643, Morinus, 'Alæ telluris fractæ, contra Gassendum;' 1643, Claramontius, 'Antiphilolaus;' 1644, Polaccus, 'Anticopernicus Catholicus;' 1645, Rheita, 'Oculus Enoch et Eliæ' (defence of the Tychonic system); 1645, Bouillaud, 'Astronomia Philolaica;' 1645, Christian, 'Disput. de trip. mundi system.;' 1645, Grandamicus, 'Nova Demonstr. immob. terræ ex virtute magnetica;' 1646, Rosse, 'The New Planet no Planet,† or the Earth no Wandering Star, except in the wandering heads of Galileans' (answer to Wilkins); 1647, Gassendi, 'Institutio Astronomica;' 1649, Gassendi, 'Apol. in Morini lib. cui tit. Alæ telluris fractæ una cum tribus Galilei Epistolis de Conciliatione Sacræ Scripturæ cum systemate telluris mobilis; 1651, Riccioli, 'Almagestum Novum;' 1653, Dubois, 'Dialogus Theologico-astronomicus;' 1655, Herbinius, 'Examen Controv. famosæ,' &c.; 1656, anonymous, 'Demonstr. math. ineptiarum J. Dubois;' 1665, Fabri, 'Dial. phys. in quibus de motu terræ disputatur;' 1668, Riccioli, 'Argomento fiscico-matematico contro il moto diurno della terra;' 1680, Bianchini, 'Dial. contro il syst. Copern.;' 1682, Megerlinus, 'Syst. Mundi Copern. demonstr.'

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[*] The Papal power must, upon the whole, have been moderately used in matters of philosophy, if we may judge from the great stress laid on this one case of Galileo. It is the standing proof that an authority which has lasted a thousand years was all the time employed in checking the progress of thought. There are certainly one or two other instances, but those who make most of the outcry do not know them.

But the most amusing application of the case before us is that frequently made by the unknown writers who publish their own great discoveries. They generally cite the *persecution* of Galileo as a parallel to the *neglect* of themselves.

[†] Mr. Drinkwater states that both Copernicus and Galileo remain in the Index Expurgatorius for 1828, with 'nisi corrigatur' to each. It is known however that the omissions and alterations with which the former author was allowed to be read were settled in 1620.

The controversy ceases to have any interest after the publication of the 'Principia' of Newton. Even to this day we believe there are some who deny the earth's motion, on the authority of the Scriptures, and every now and then a work appears producing mathematical reasons for that denial; these works, as fast as published, after making each two converts and a half in a country town, are heard of no more until fifty years afterwards, when they are discovered by bibliomaniacs bound up in volumes of tracts with dissertations on squaring the circle, and perpetual motion, and pamphlets predicting national bankruptcy.

We shall now recapitulate some of the arguments against the earth's motion, taking first the scriptural and afterwards the physical.

The scriptural arguments are of two kinds, Copernican and anti-Copernican; for it must be remembered that the asserters of the earth's motion, almost with one accord, admitted the Scriptures as a judge of the controversy. The following are some of the texts and arguments. We take them from Fienus, Fromond, Morin, Rosse, and Riccioli on the one side, and from their statements of their opponents' arguments, or from Wilkins, on the other.

Psalm xix. 4, 5, 6: "In them hath he set a tabernacle for the sun, which is as a bridegroom coming out of his chamber, and rejoiceth as a strong man to run a race. His going forth is from the end of the heaven, and his circuit unto the ends of it." Here it is remarked that the metaphor, where it exists, is explicit, in "*as* a bridegroom," "*as* a strong man," but that the words which apply to the sun's motion are absolute assertion.

Ecclesiastes, i. 4, &c.: "One generation passeth away, and another generation cometh; but the earth abideth for ever. The sun also ariseth, and the sun goeth down, and hasteth to his place whence he arose. The wind goeth towards the south, and turneth about unto the north." In the Vulgate, the last sentence refers to the sun: "Oritur sol et occidit, et ad locum suum revertitur, ibique renascens gyrat per meridiem, et flectitur ad aquilonem."

Joshua, x. 12: "Sun, stand thou still upon Gibeon, and thou, moon, in the valley of Ajalon. And the sun stood still, and the moon stayed. . . . So the sun stood still in the midst of heaven, and hasted not to go down about a whole day." It was contended that the earth ought to have been made to stand still, "if Joshua had been a Copernican."

2 Kings, xx. 11: "And he brought the shadow ten degrees backwards, by which it had gone down in the dial of Ahaz." Isaiah, xxxviii. 8: "So the sun returned ten degrees, by which degrees it was gone down."

Psalm xciii. 1: "The world also is stablished that it cannot be moved." Psalm civ. 5: "Who laid the foundations of the earth, that it should not be removed for ever."

Job, ix. 6, &c.: "Which shaketh the earth out of her place, and the pillars thereof tremble; which commandeth the sun, and it riseth not, and sealeth up the stars."

Job, xxxviii. 4, &c.: "Where wast thou when I laid the foundations of the earth? . . . Whereupon are the foundations thereof fastened? or who laid the corner-stone thereof? . . . Where is the way where light dwelleth? and as for darkness, where is the place thereof?"

The Copernicans cited the preceding, Job, ix. 6, and the following, Psalm xcvii. 4, "The earth saw, and trembled;" and Psalm xcviii. 7, which in the English version, is "Let the sea roar, and the fulness thereof, the world, and they that dwell therein;" but in the Vulgate, "Moveatur mare et plenitudo ejus, orbis terrarum, et universi qui habitant in eo." The Ptolemaists replied, with reason, that these texts evidently imply a violent and unusual motion, while all the others speak of stability as the common order of things. We look upon Fromond as, next to Riccioli, the most learned and sensible of the anti-movement party, while Lansberg is certainly not the least of the Copernicans. Yet the latter, to fill up the immense void between Saturn and the fixed stars, states that it is crowded with spirits good and evil, employed in their vocations: the former meets him by the following argument. By the universal consent of theologians, hell is at the centre of the earth; the creed says that Jesus Christ "descended into hell;" and St. Paul, in Ephesians, iv. 9, that he "descended into the lower parts of the earth." The empyreal heaven, and the habitation of the blessed, must be as far as possible from hell; but the former was, by consent of theologians, at the circumference of the universe; therefore, says Fromond, the earth must be at the centre. But Morinus outdoes the rest. From the creed, he says, it appears that Jesus Christ "ascended into heaven;" and from the first chapter of Acts, that he was "taken up." It is generally thought that the hour of the ascension was noon, at which time, according to the Copernicans, the heads of persons on the earth are towards the centre of the system (the sun). Consequently it was not an ascent, but a descent, for to go towards the centre is to descend. I know, says Morin, that the Copernicans have a subterfuge and a fallacy, for they say that the ascent was an ascent with respect to the earth only; and he goes on to show what shuffling knaves they were, for so direct a perversion of plain words. It is, however, but fair to the anti-Copernican party to add that Riccioli, by far the most learned of all of them, has not thought Morinus worthy of one word of mention in his list* of writers on the subject.

Riccioli cites the following additional texts. Genesis, xv. 12: "And when the sun was going down," &c. Gen., xix. 23: "The sun was risen upon the earth." Gen., xxxii. 31: "The sun rose upon him." Judges, xix. 14: "The sun went down upon them." Matthew, v. 45: "He maketh his sun to rise on the evil and on the good;" with several others to the same purport. Also Psalm lxxv. 3: "The earth and all the inhabitants thereof are dissolved: I bear up the pillars of it." He adds all the places in which "heaven above" and "earth beneath" are mentioned.

The Copernicans, besides the very few passages which they could find alluding to a motion of the earth (and that only an unusual one), brought forward texts in which admitted errors exist; such as the Mosaic definition of the firmament, the circumference of Solomon's brazen sea (which, the diameter being ten cubits, must have been upwards of thirty-one cubits in circumference, and not thirty, as stated), and the like. To this the general answer was, that there is a great difference between stating round numbers, according to usual measurement, and absolutely asserting untruth. Riccioli however lays it down that the obvious literal sense of the Scripture is to be taken, except where it is manifestly false; that Archimedes had shown the proportion of ten to thirty to be false, but that no one had actually shown the earth to move. This was evidently convenient, but unfair; the motion of the earth was the thing in question, and could not be proved false by assuming a literal interpretation, which, it was admitted, might be rejected if the earth's motion were true.

Upon a review of the passages cited, it is clear enough that, if there be any astronomical system at all in them, it is that of an immoveable earth and a moveable sun; while if there be no astronomical system, it follows that vulgar notions are adopted in the modes of expression, which represent appearances without reference to their truth or falsehood. On one horn or other of this dilemma, all our modern Urbans must be content to abide: will they go back to Ptolemy, or forward with the advance of science? Can they show any reason why the astronomical system of the old Testament should be rejected, and those passages which appear to favour one geological theory rather than another should not only be received, but be enforced upon others by clamours of latitudinarianism, infidelity, and all those reproaches by which (and fortunately, by which only) untolerated differences of opinion are punished?

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* The Preceptor of Hevelius.

† Lalande gives a Latin title; we do not know whether it was published in Latin at the same time or not.

* Since then this is a list selected by the latest writer of note, as well as the most learned, it may be worth while to give the names.

Copernicans: Copernicus, Rheticus, Maestlinus, Kepler, Rothmann (except when he followed Tycho), Gilbert, Foscarini, Zuniga, Bouillaud, Lansberg, Herigone, Gassendi, Des Cartes.

Anti-Copernicans: Aristotle, Ptolemy, Theon, Regiomontanus, Alfraganus, Cleomedes, Macrobius, D'Ailly, Buchanan, Maurolico, Clavius, Barocius, Neander, Telesius, Martinengus, Lipsius, Scheiner, Tycho, Tassonus, Claramontius, Inchofer, Fromondus, Lagalla, Tanner, Bart. Amicus, Rocco, Mersenne, Polaceus, Kircher, Spinellus, Pineda, Lorinus, Mastrius, Bellutus, Pontius, Delphinus, Elephantutius. Many of these are theologians only.

That the attempt to enforce a system of science derived from an interpretation of the Scriptures will signally fail, should be taught by the history of the past. Not even the Church of Rome will ever again dictate on a question of fact, and in Protestant countries (and Catholic too, we suspect) public opinion must and will support absolute proof against doubtful interpretation. The opponents in this matter are, some of them, men of learning, like Fromond and Riccioli; others men of conceits, like Morin.[*] The former seize the stronger parts of their own case, but they will find that it requires a better foundation than imposition of interpretations to bear the sort of support which the latter afford. A compact college of cardinals might more safely make the attempt than a miscellaneous party.

The declining days of what was called the Aristotelian philosophy had their span much shortened by the glaring light into which it was thrown when held up against the results of the philosophy of Galileo; and this not more by the exhibition of the Ptolemaists than of their opponents the Copernicans. The latter were taught that rational mechanics must precede simple astronomy; and it is no exaggeration to say that not an inconsiderable portion of that power over nature which we now have, can be traced in its earliest growth to the necessity of finding stronger weapons to oppose the old system than were forged in the philosophical workshops of the age we have been considering.

The physical arguments of the time consisted much in supposing inclinations, propensities, and almost feelings of privilege and place, to exist in different sorts of matter. A comet, says Fromond, is "not such an obscene ape of the planets that nature should have manufactured a sphere and a heaven for it to revolve in;" and the proper pride of a comet was the sufficient reason for one motion rather than another. The arguments for the sun's motion and the earth's stability may be condensed as follows. Aristotle and Ptolemy assert it; the Scriptures assert it (Fienus puts them second); the heavenly bodies are made for man, and the servant comes to his master, not the master to the servant; the natural motion of earthly bodies (as when falling) is in a right line; a body cannot have two natural motions, therefore the earth cannot move in a circle; if the earth moved, an arrow shot upwards could not fall on the spot from whence it was shot; the air, differing from the earth in substance, cannot be moved at the same rate, consequently, mountains, towers, &c., would produce a wind if the earth moved: a stone let fall from a height would not fall directly under the point which it leaves; an arrow shot towards the east would go much farther than one shot towards the west, the first having the air with it, the second against it; houses, and the earth itself, would be broken to pieces by so rapid a motion, which however the heavens can bear, being made of iron, *according to Homer*, while the earth is soft and friable; the immensity of the distance which must exist between the orbit of Saturn and the fixed stars, if the whole orbital motion of the earth produce no effect upon the latter; the excessive greatness of the fixed stars on the same supposition; &c. &c.

The Copernicans contended generally for the greater simplicity of their system, and the incredibility of the enormous velocity which the sphere of the fixed stars must have if the Ptolemaic hypothesis were true: to which it was answered, that God "doeth great things past finding out, and wonders without number;" that the earth would corrupt and putrefy without motion, whereas the heavens are incorruptible: answer—that wind, &c. give sufficient motion; that the most moveable part of man is underneath, since he walks with his feet; whence the most unworthy part of the universe (which all parties called the earth) should be moveable: answer, that the Copernicans were absurd (as in fact they were) for taking the earth *out of* the centre of the universe upon an argument the force of which was derived from its being *in* the centre (or lowest part); also, which is theoretically true, that if the earth move, the head of a man moves faster than his feet; that rest is nobler than motion, and ought therefore to belong to the sun, the nobler body: answer, that for the same reason the moon and all the planets ought to rest; that the lamp of the world ought to be in the centre: answer, that a lamp is frequently hung up from a roof to enlighten the floor; that there is a cause of motion (magnetism) in the earth: answer, that no Copernicans had examined the sun, or they might perhaps have found as good causes of motion there; that the Hebrew word for the earth has a root which signifies motion—which on the other side was contended to apply to the motion of animals upon its surface.

Such were the more common arguments of the Copernicans; others may be seen in a paper entitled 'Old Arguments against the Motion of the Earth,' in the 'Companion to the Almanac for 1836.' We do not charge every one, either of the Ptolemaists or Copernicans, with all the absurdities above noted; but we have not found one of either side free from such *à priori* attempts at a knowledge of the nature of things. Our countryman Bishop Wilkins has less of this sort of argument than any one except Galileo, and he deals with the scriptural objections in a very learned and able manner. He points out the absurdities into which the Fathers had fallen by a degree of literal interpretation which had become obsolete even in the days of Fromond: how, for instance—Basil made the moon greater than any of the stars, because Moses calls the sun and moon the two greater lights; Justin Martyr and several others supposed a vast body of water above the starry firmament; St. Augustine concludes the visible stars to be innumerable; many fathers assert that the heavens are not round, but stretched forth as a curtain; some that the sea not overflowing the land was not a consequence of the usual laws of matter, but a perpetual miracle; some that the sea is higher than the land, because it is called "altum," translated by us "the deep;" some that the earth is placed upon the sea; some say that the stars have understanding and speech, and, according to Origen, moral responsibility. All these things follow, either at once, or by the most universally admitted species of inference, from the literal signification of words in the sacred Scriptures. These interpretations vanished first; those who sailed round the world destroyed the greater number of them; and the abandonment of them was acquiesced in even by those who would have nailed the earth to a Hebrew word. The earth itself was next allowed to move, when Galileo had established a mechanical system which would reconcile such motion with terrestrial phenomena, as completely as that of Copernicus and Kepler with celestial. The time came when even divines might insist on this simplicity of motion in illustration of the wisdom of the architect. But the structure of the earth had not been examined; consequently when the conclusions of geological induction began to appear, the old method was ready, the texts were forthcoming, neither was interpretation wanting, nor those who would raise an outcry against the results of examination and the investigators, because the former would not agree with the interpretation, nor the latter be fettered by its imposition. The same course will be run, with the exception only that the enemies of free inquiry and honest statement are not so numerous nor so powerful as in the 17th century, so that the effect will be less, both in extent and duration. So very slight have been the scientific attainments of the opposing party on this occasion, that it becomes those who are interested in the history of the sciences to take some measures for the preservation of their writings, since it is found that the purely theological works against the motion of the earth are extremely scarce, while only those which unite science, such as it was, with theology, are now[*] in any degree diffused.

If we throw away all the arguments which would now be considered fantastical, we shall find the sense of both sides of the controversy contained within very narrow limits. The strength of the Copernicans lay in the simplicity with which they exhibited the celestial motions, that of their opponents, in the then unanswerable argument of the throwing up of a stone. Both parties believed that the stone of itself would not follow the motion of the earth; at least such was the opinion until the Galilean philosophy was fully received. Fromond shows his penetration when he says that the Copernican philosophy will finally be wrecked on this argument; had he admitted an alternative, and assumed either that the mechanical argument would destroy the motion of the earth, or the motion of the earth would lead to an entire change in the principles of mechanical philosophy, no one would now have disagreed with him.

We shall close this article with a mention of the actual proofs of the motion of the earth.

1. It is difficult to believe, in the present state of mechanical knowledge, that any heavenly body is at rest, and the burden of proof must lie upon those who assert rest, and not upon those who believe in motion, which a person instructed in mechanics must do, until the contrary is proved.

2. If a motion existed, a centrifugal force would arise, which would produce an effect on the oscillation of a pendulum tried in different parts of the earth. [CENTRIFUGAL FORCE; PENDULUM.] Such an effect is found to be produced corresponding to that which should be produced by the earth's rotation; nor have those who deny that rotation ever produced any explanation of the phenomenon.

3. An experiment has been tried, which it will be worth while to describe, and which Delambre says had "a sort of success." When we say that a stone let fall from the top of a high tower should fall precisely under the point from which it started, we say that which ought not to be perfectly true; the reason is as follows:—The starting point of the stone, being at a greater distance from the centre than the point directly under on the earth, describes a somewhat larger circle, and moves a little quicker. The stone therefore at the commencement of its fall has a motion from west to east, a little more rapid than the under point of the earth. The resistance of the air, though it exists with respect to the fall of the stone, does not exist with respect to the motion from west to east since the air, earth, and

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[*] This worthy, to a great capacity for finedrawn deduction, added the power of an astrologer, and some art in extricating himself from the scrape of an unfulfilled prophecy. When Gassendi remained alive after the time which Morin had positively fixed for his demise, the latter persisted that the non-fulfilment of the prophecy was in consequence of the warning which it gave Gassendi, whose health was declining, to try change of air.

[*] There are, it is well known, different degrees of scarceness in old works. We have met with Riccioli, Fromond, Morin, Fienus, Rosse, Wilkins, Gilbert, &c., exposed for sale in London, within these five years, and with several more than once; but we never met with any of the purely theological authors quoted by Riccioli.

stone are carried together: consequently the stone should fall a little east of the foot of the tower. This experiment was tried at Bologna by Guglielmini, who published his results in a work called 'De Motu Terræ diurno,' Bologna, 1792; it was repeated at Hamburg: the heights were respectively 241 and 235 feet (French).

In every instance the projected body fell a fraction of an inch to the east, and never to the west of the point directly under the point of projection. Had this departure been an accidental effect, it is incredible that it should always have taken place in one direction. Delambre does not state the number of experiments made; but if it were only six, and if the chances of departure east or west had been equal, it would have been 63 to 1 against the departure being always in one direction. In the last two proofs we are made to perceive the earth's rotation, by phenomena which can be explained on no other hypothesis that is worth consideration.

4. We perceive the earth's *orbital* motion only in the phenomenon of **Aberration**, from which one of two things must be true; either the earth moves round the sun, or light does not move in a straight line; and what is more, the light from every star, in whatever part of the heavens it may be found, changes its course with the position of the sun. The change, it is true, is minute, but it is as well established as it would be if it were visible to the naked eye; and it must be remembered that twenty seconds is not a small quantity when the eye is applied to an instrument capable of measuring one second. Were there no other phenomenon by which to test it, the orbital motion would be conclusively proved by that in question.

5. The next argument is analogy, which, though not perfectly conclusive itself, lends a great additional force to the rest. The planets all exhibit motion round the sun; this can be proved; and the only question that remains is, whether the sun move round the earth, carrying the planets round itself, or whether the earth be itself a planet moving round the sun. The planets also, in most cases, revolve round axes visibly, and there is no proof that any one does not.

6. The last argument is authority, properly used. There are many who do not know enough of the subject to decide even between Newton and the worthy Frenchman, whose name is unnecessary to mention, who thinks he proves the planets to be reflections of the sun upon the polar ice, and the southern hemisphere of stars to be a reflection of the northern upon a very curious crystal plane, but how placed we do not exactly know. With such persons authority must decide, if there be any decision at all in their minds; and it is of some importance to them to know what sort of authority they trust to. The argument from authority may be thus summed up:—1. The motions of the heavenly bodies are irregular, particularly those of the moon, which, when closely examined, exhibit irregularities, the cycles of which never were determined from observation alone. 2. At the time when the controversy about the earth's motion took place, the time of the moon's transit over the meridian, for instance, could not be predicted within several minutes. 3. By means of the labours of Newton and his successors in theory, and Flamsteed and his successors in observation, the prediction now rarely differs from the result by more than half a second of time. 4. It has been the unanimous opinion of those concerned in bringing astronomy to this state, not merely that the earth has a motion both of rotation and orbital progression, but that the proofs are such as to leave no doubt whatsoever on the subject; nor is it in history that any person who was mathematician enough to read the writings of Newton ever entertained any hesitation upon the subject.

7. For the recent experimental proofs—proofs to those who have the requisite knowledge of dynamics—of the motion of the earth, see **Gyroscope**; **Pendulum**.

A short time after the article **Galileo**, was first published, there appeared in a leading Roman Catholic publication, the 'Dublin Review' (July, 1838, vol. v. pp. 72-116), a controversial article upon the celebrated interference of the Inquisition. This article was much cited, and seems to have been considered by some, at least, of the English and Irish Roman Catholics as a triumphant reply to the account usually given. We shall here briefly examine the main assertions, and the question which arises out of them.

We have already expressed our opinion of the use which is made of Galileo's trial by Protestants: and we repeat that Roman Catholics have a good right to consider the manner in which this case is harped upon as a high compliment to the authority which through so many centuries possessed the power of doing as much or more on every day of every year. That the whole proceeding was disgraceful to the parties concerned is generally admitted even by Catholics; but the question, and one which has not been fairly handled by Protestants, is, how far those parties can claim to be the representatives of the church which declares itself infallible in matters of faith. The importance of Galileo's trial depends upon its connection with this question; and party zeal has mixed up with it all manner of discussion upon the character of the proceeding itself, and the motives of those who originated it. Englishmen would do well to remember, with regard to the latter points, their own Star-Chamber, the astronomy[*] of the Act of Uniformity, and the decision of the University of Oxford [*] that no woman has a right to defend herself against the king.

Even in Italy the defence of the Inquisition has been long and openly given up by many. Witness the expressive silence of the account of Galileo, in the 'Elogi degli Uomini illustri Toscani,' Lucca, 1772, taken from a contemporary Milan periodical; the declaration of Frisi (Milan, 1775) that "the imagination is horrified, and the virtuous and feeling mind shudders," at the language applied to Galileo in the sentence passed upon him; and that of Fabbroni (Pisa, 1784), that "it is better to be silent upon the details than by recalling them to increase the horror which every virtuous mind ought to feel against the injustice of that time." And the article in the 'Dublin Review' styles the Inquisition "superlatively cruel in Spain, more mild and sparing of human life in Rome"—only more mild than superlatively cruel.

That the Roman *Church* decided against the earth's motion has been generally affirmed by Protestants, and denied by Catholics, we believe with justice. But that the church which claims infallibility in essential matters suffered two local tribunals, the office of which was the suppression of heresy, to pronounce, and, as it turns out, to pronounce wrongly, upon a question of astronomical fact, is all but universally admitted. Nevertheless, even this is denied altogether by the author of the article before us, whose account of the matter is as follows—That Galileo, in 1615, not content with supporting the Copernican doctrine as a truth, which it was open to him to do, persisted in invading what himself admitted to be the prerogative of the church, by declaring that the sacred Scriptures could be interpreted against Ptolemy and for Copernicus; and this, in spite of many friendly warnings, that he must confine himself to "demonstrating his system," and writing "as a mathematician, and by way of hypothesis." That when the first attempt was made upon him in 1615 (which was rejected by the Inquisition for informality), as much licence as the above was distinctly mentioned as given to all. That the prohibition of 1616, to teach or write in favour of the Copernican doctrine, was a prohibition to Galileo only, not to others, and was brought about partly by Galileo's persisting in forcing the theological question upon the court, and partly by the imprudence of his advocate, Cardinal Orsini, in pressing the subject upon the pope. That before this prohibition was given, on the occasion of Galileo's first personal appearance, the qualificators of the Inquisition, whose office it is to put the propositions bearing on the points at issue before the court, drew up the two famous theses, in which the doctrine of the earth's motion was called false and heretical. That when Galileo, in 1632, brought on the proceeding of 1633, not only by a breach of the prohibition, but by a sarcastic reference to it, and a caricature of the arguments of his friend and benefactor, the reigning pope, these theses were merely cited in the preamble of the sentence, and are not there to be taken as anything but recapitulation. That the word heretical, in the proceedings of the Inquisition, is the *stylus curiæ*, and that even offences against morals or the public peace, apart from all doctrine, must be styled heretical, before that court can assume jurisdiction.

In the above are the following assertions. 1, That any one (except Galileo, restrained for his own misconduct) was at liberty to teach the earth's motion as true, provided he confined himself to philosophy, and let theology alone. 2, That the Inquisition pronounced no opinion upon the truth of the doctrine. 3, That it pronounced no opinion upon the orthodoxy of the same. We deny each of these positions, upon the clearest reasons, which we shall bring forward. But we do not deny that much has been stated which, when closely examined (for articles in reviews do not deal in references), would probably establish the fact that the prohibition of 1616 was mainly due to the injudicious ardour with which Galileo pressed the theological question. Nor do we deny that the conduct of the philosopher was weak and ungrateful in putting into the mouth of the wrongheaded personage of his dialogue the arguments urged to him in personal conference by his benefactor Urban, with a hint that they came from a high quarter. All parties admit that it was the irritation of the pope at this conduct which led to the final proceeding.

As to the first of the preceding assertions. There were, at the time in question, three distinct modes of maintaining a theory. First, as a mathematical hypothesis, assuming it not as true, but as sufficient to explain phenomena, and leaving its truth or falsehood aside, or even implying the latter. Secondly, as a truth, but without any reference to the Scriptures: maintaining it by arguments, and implying that if the Scriptures really assert the contrary, there must be something wrong in those arguments, but that if the latter really amount to demonstration, then the interpretation of the Scriptures, which makes them assert the contrary, must be wrong. Thirdly, as an absolute truth, confirmed by reason and Scripture both. In the article we are examining, the first and second of these modes are confounded: and it is thought that when Galileo was warned off the third mode, and told to write "as a mathematician and by way of hypothesis," and to confine himself to "demonstration," he was left with permission to use the second mode. This is not correct, but the mistake is a natural one. We have already seen [DEMONSTRATION] that demonstration, as applied to physical hypothesis, meant only explanation: and that it could be said that a false hypothesis might give true demonstration; that is, might be shown to be capable of accounting for phenomena. To learn how matters stood in the present case, we must look to the words of the authorities. Of these there were two, the Inquisition, which took cognisance of the acts of heretics, and the Congregation of the Index, which examined and censured their books. In one and the same year (1616) the former silenced Galileo, the latter condemned the great work of Copernicus, and the writings of his followers. The decree which condemns them calls the doctrine of the earth's motion "false and altogether contrary to Scripture." And this decree prohibits not only the work of Foscarini, which endeavours to show that the doctrine is not contrary to Scripture, but also that of Copernicus, which does not touch the question of theology. This is plain enough, but we can make it still plainer. Four years after (1620), the same Cardinals of the Index, finding that the work of Copernicus could by slight alterations be made to speak the language of hypothesis, published the corrections under which they would allow it to be read. We put a few sentences of the work side by side with the alterations dictated by authority:—

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[*] The poor nonconformists (see Calamy's 'Life of Baxter') pleaded in vain that they were required "unfeignedly to assent and consent" to declarations which distinctly implied that it was full moon at times when any one could see that it was little more than half moon. And to make this more remarkable, it should be remembered, that in the year following it was proposed to insert into the act for relief of those who had not subscribed on account of sickness, a clause declaring the assent and consent to be nothing more than a declaration of obedience. This clause passed the Lords, but was rejected by the Commons, and the bill passed without it.

[*] It was in 1622, between the two proceedings against Galileo, that the Convocation at Oxford promulgated this doctrine. (Wood, 'Historia,' &c., pp. 326–328.) William Knight, with a meaning perhaps both seditious and offensive, had publicly maintained that if the sovereign were to attack a subject, *tanquam latro aut stuprator*, and if no other help were nigh, the subject might defend himself or herself as against any other assailant. The university, not content with committing Knight to prison, declared the proposition *false*, dangerous, and impious; and enacted that all candidates for degrees should subscribe this censure, and make oath that they would neither hold, teach, nor defend this opinion. The false physics of the Inquisition seems to have the evidence of the senses in its favour; the false morals of the Oxford convocation has always found its denial in the heart and conscience of every honest man and of every honest woman.

Copernicus.	*Correction required.*
This question (of the motion of the earth) is not yet settled, and is not to be despised by any means.	It matters nothing whether the earth be taken as the centre [remember that the word centre in those days implied immoveability] or not, so far as solving the phenomena of celestial motions is concerned.
Since then there is *nothing to hinder* the motion of the earth.	Since then *we assume* the motion of the earth.
On the triple motion of the earth (heading of a chapter).	On *the hypothesis* of the triple motion of the earth.
These three stars (the earth being one).	Omit these words, because the earth is not a star, as Copernicus makes it to be.

This surely will settle, in reasonable minds of all persuasions, the question how much is permitted to a person speaking as a mathematician, and by way of hypothesis. If Copernicus say the earth is a star [a word implying motion], the cardinals strike it out: if that it may be so, they alter it into a professed assumption for purposes of calculation. How indeed could they allow *nihil prohibet* on an opinion described by themselves as *Divinæ Scripturæ omnino adversantem?* For the documents cited see Riccioli, 'Almag. Nov.,' lib. ix. sect. iv.

Next, as to the assertion that the Inquisition pronounced no opinion on the truth of the doctrine. The two propositions, affirming both its falsehood and heresy, were drawn up, it is said, by the qualificators or qualifiers, inferior officers of the court, and not the court itself. This is a strange argument, and to make it relevant to any point it must be shown that the declaratory power of the Inquisition was lodged in its inferior officers, and not in its judges. If the tribunal were so constituted, it matters nothing to the point in question; for the qualifiers did declare against the doctrine, that is, the court did pronounce a decision in its usual form and manner, and we assert nothing more. All that was done in any other case was done in this one. But in point of fact, it will be found that the qualifiers are only the assistants of the judges; and the voluntary adoption of their conclusions by the cardinals makes those cardinals themselves the responsible parties. But further: it is not true that the final sentence of 1633 did no more than state the theses of the qualifiers as recapitulation of the proceedings of 1616. The defence before us asserts that the Inquisitors "did not at all trouble themselves with considering the truth or falsehood, the innocence or poison, of the opinion asserted." To this let the sentence itself reply:—"And that this pernicious doctrine might be altogether removed, and might not further creep in, to the great injury of Catholic truth, a decree emanated from the Sacred Congregation of the Index, by which the books which treat of this doctrine were prohibited, and the doctrine itself was declared false, and altogether contrary to Scripture. But since a book has appeared at Florence in the past year (1632), of which the inscription shows that you [Galileo] were its author, the title being 'Dialogo,' &c., and whereas the sacred Congregation has come to know that since the printing of that work the false opinion of the motion of the earth has increased more and more from day to day, the said book was diligently considered," &c. And in the recantation Galileo is made to say that the opinion of the earth's motion is false and heretical, and that he abjures and detests that error and heresy. It thus appears that there are four parties who declare the doctrine false and heretical—the qualifiers, the Inquisitors, the Congregation of the Index, and (perforce) Galileo himself.

Next, as to the question whether the Inquisition declared the doctrine heretical. That, so far as its authority extended, and in its own usual sense and meaning of the word, it did do so, is clear enough from what precedes. But, as may be supposed, a general word which belongs to an extensive system of law has many uses. The argument about the *stylus curiæ* seems to us unanswerable. In our Court of Queen's Bench, peaceful persons were adjudged to have done many things by force and arms, because the court, originally instituted for matters connected with the Queen's peace, had no other way of widening its jurisdiction for the relief of the subject except by interpreting one class of injuries after another as acts of violence. The Inquisition, instituted for the suppression of heresy, and having no choice but to determine all cases sent before it by the Pope (as was that of Galileo), was as much compelled by its forms to consider every point with nominal reference to heresy and orthodoxy, as the Court of Queen's Bench to decide actions for breach of contract on a supposition of money detained by force. Whether the maxim of our law—*in fictione juris semper subsistit æquita*—can be applied to the Office called Holy; whether the high authority which Roman Catholics reckon to be infallible when it *does* pronounce a decision was not culpably negligent in withholding its power from the scene of action, and in allowing an inferior tribunal to assume the function of interpretation which it asserts to belong peculiarly to itself—are questions on which Roman Catholics themselves are likely enough to be divided in opinion. But however this may be, to require them to admit that their church has decided against the motion of the earth, as a matter of faith, and in its asserted infallible character, is to ask them to yield more than the opponents of the disputed doctrine ever thought they could claim as having been done for them. On this point we can cite a most unwilling contemporary witness, Fromond of Louvain, whose 'Antaristarchus,' written against the motion of the earth, was published at Antwerp in 1631. Fromond was a very zealous Roman Catholic, an ardent opponent of the Copernican doctrine, and a firm believer in the fact of the sacred writers having intended to declare the stability of the earth. One of his chapters is thus headed, "Is the Copernican opinion now to be held heretical?" This of itself is something, for it is to be remembered that the work had passed through the hands of the united censure of Philip IV. of Spain and the ecclesiastical authorities. What would these examiners have said to a work on the Nicene Council with a chapter headed "Are the followers of Arius to be considered as heretics?" But to proceed:—Fromond, who wants to get all the condemnation that he can for his opponents, begins by citing Roman Catholics who have expressed opinions on the subject and it is remarkable how mild the censure is, even of those who wrote after the decree of the cardinals. Tanner says the opinion is "condemned, and cannot any longer be safely held;" Mersenne, that "any one may justly think it rash,* particularly after the manner in which the cardinals have expressed themselves." The author goes on to state, with a slight, but very slight, tone of reproach, that there are men, both learned and Catholic, in Italy, France, Germany, and Belgium, who care little for the opinion of the cardinals, and who say that the power of these dignitaries is not supreme and pontifical, and that until this last-named power is exerted, they are safe and not within the limits of heresy. But Fromond doubts whether they are "safe enough." He points out that the books which are in the Index are condemned (according to the bull of Sextus V., which modelled both the Index and the Inquisition into the form which they had when Galileo was silenced) by the authority of the pope, expressly delegated for that purpose; and he then feels justified in drawing the following inference. "If," says he, "the general opinion of the Catholics of our time be correct, namely, that the pope speaking *à cathedra* cannot err, though not supported by a general council, then it is all up with Copernicus, and his paradox (to use a gentle word) appears rash, and next thing to heresy, ay, even more." Having thus, as it were, made his utmost point, and still not got quite so far as heresy infallibly pronounced, he checks himself thus: "This is what a severe judge might think. But when I consider how circumspect and free from haste pontiffs generally are in their decrees on matters of faith *à cathedra*, and also their practice of making those decrees in their own names and not in those of others, and since Sextus V., in the diploma which established the fifteen congregations of cardinals expressly says, 'Of those decrees which relate to the dogmas of the faith, we reserve the interpretation to ourselves'—it seems necessary to mitigate the censure a little, and right to suppose that the authority of the Congregation of the Index is not equal, but inferior, to that of the pope." He ends by saying that though the Copernican has (unless the pope should otherwise decide) one foot inside the door of heresy, yet he would not dare to pronounce him an open heretic, without something more express from the head of the church. The bull of Sextus V., as we see, contains an express limitation of the power of the several congregations; and the language and arguments of Fromond (to whom we might join other writers, but not of so satisfactory a character, as being themselves Copernicans) prove that this renunciation of the charge of heresy, this declaration that the asserted infallible power never showed itself, is no subterfuge of modern Romanists, but was the argument of the time when Galileo was under the ban; was held, among others, by a distinguished opponent of the Copernican doctrine, the very last person who was likely to have had any bias towards such reasoning; and was allowed to pass a strict censorship of the press.

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* This word rash, *temerarius*, is of great force. It had a technical meaning, and was constantly used at the time of which we write, as for aught we know it may be now, as an epithet distinctive of an offence minor to heresy. Accordingly when a priest styles the opinion *rash*, it is to be inferred that he would refuse to say it was *heretical*: just as hearing a lawyer call an offence manslaughter, we should suppose him to deny that it amounted to murder. So that, when Mersenne qualifies as only *temerarium* that which the court of which he is speaking had pronounced *falsum et formaliter hæreticum*, he limits the power of that court in the same manner as Fromond did, though more briefly.

In 1651 the theologian Riccioli, the most learned of astronomers, and the strongest of the anti-Copernicans, writes as follows:—"The sacred congregation of cardinals, taken apart from the supreme pontiff, does not make propositions to be of faith, even though it should actually define them to be of faith, or the contrary ones heretical. Wherefore, since no definition upon this matter has as yet issued from the supreme pontiff, nor from any council directed and approved by him, it is not yet of faith that the sun moves and the earth stands still, by force of the decree of the congregation; but at most, and alone, by the force of the sacred Scripture, to those to whom it is morally evident that God has revealed it. Nevertheless, Catholics are bound, in prudence and obedience, at least so far as not to teach the contrary. But of this subtility * of theology I have treated in my treatise 'De Fide.'"

But not only do Roman Catholic writers thus express themselves, but contemporary Protestants, the most staunch opponents of Rome, accept the interpretation. Thus Bishop Wilkins, a decided Puritan, writing in 1640, after stating that some individuals, as Serrarius, expressly condemn the Copernican doctrine as a heresy, proceeds as follows: "And since him, it hath bin called in [question?] by two Sessions of the Cardinals as being an opinion both absurd and dangerous. And therefore likewise doe they punish it, by casting the Defenders of it into the Pope's truest Purgatorie, the Inquisition: by yet neither these Councels, nor any (that I know of) since them, have proceeded to such a peremptorie censure of it, as to conclude it a heresie; fearing, perhaps, lest a more exact examination, and the discoverie of future times, finding it to bee an undeniable Truth, it might redound to the prejudice of their church, and its infallibilitie."

It is moreover to be remembered that the Inquisition, and even the Congregation of the Index, was a local authority, incompetent to legislate for the faith of all Roman Christians. There was nothing in what was done by the Italian to hinder the Spanish Inquisitors from declaring in favour of Copernicus, if such had been their pleasure: and, in fact, we have searched the Spanish Index of 1667 in vain for the name of Copernicus, though some of his followers are in the list.

Lastly, if we remember the controversy which has always existed in the Roman world as to the character of decrees emanating from the Roman See alone, without a general council, we shall see that it would have been very unlikely that a pope should have raised this question in France, Spain, and Germany, upon a matter which might any day be settled against him by absolute demonstration. Tiraboschi looks upon it as a special Providence that the Church was not allowed to commit itself; and we apprehend that most Roman Catholics will be of his opinion. But they must admit, as they have had to do in many other cases, that their earthly head used his power in a most unworthy manner, and found agents who were the subservient creatures of his irritated feelings. Protestants, on the other hand, should beware how they weaken the general argument against the infallibility of the Roman church, by practically owning that it cannot be successfully attacked except by denying to those who maintain it the right to be the interpreters of the sense in which they use their own words.

Though we differ entirely from the article in the 'Dublin Review,' the substance of which we have quoted, yet it is right to say that we find in it a large quantity of collateral information, put together in a manner which strikingly exhibits the under current of favour which was setting towards the doctrines of Copernicus, when its imprudent advocates began to mix theological with their physical arguments. Had we intended this comment to be a biographical one, we should have had to make use of its details; and we should be very glad to see the numerous interesting citations which it contains worked into truer history, supported by fuller reference, and dignified by milder language towards opponents.

MOTTO, an Italian term, shortened by some of our old writers to *mot*. It means a word or sentence added to a device; and is commonly used, when put upon a scroll, as an external ornament of coat-armour. The use of mottoes for this purpose is ancient, and as appended to a coat of arms they are frequently hereditary in families. In strictness, the motto should bear allusion to something in the achievement, but in modern times the taking of it rests entirely with the fancy of the bearer, and it may be changed at pleasure. A sentence or quotation prefixed to anything written is also termed a motto.

MOULDINGS (in Architecture), any assemblage of narrow surfaces projecting from the face of a wall or other surface and also advancing one beyond the other. They are bounded by straight lines, either horizontal or vertical, according to their situation, but the surfaces themselves are *plane* or *curved*, and if the latter, concave or convex, or else compounded of both forms. Sometimes indeed, instead of projecting, mouldings are *sunk*, as is the case when they form a border within a sunk panel, for though they project with respect to the surface of the latter, they recede within the general face of the wall. The mouldings within the panels of doors are of this description. Mouldings are employed as borders to doors, windows, and other apertures, as arches, in which latter case they are termed *archivolt mouldings;* while those forming the imposts from which the arch springs are called *impost mouldings*. The bases of columns likewise consist of mouldings. They are also employed to mark the horizontal divisions of a wall, both internally and externally, and every member to which they are applied is said to be *moulded*. As their edges are straight lines, their contour can be shown in drawings only by their shadowing, and by the outline which they produce at their extremities, as in the case of a cornice. But as this is insufficient, except to afford a general idea, in working drawings and those of detail mouldings are shown on a larger scale, and by means of a section through them, by which their *profile* is accurately defined; and upon a good profile, that is, one where the mouldings are well proportioned to each other, and so combined as mutually to relieve each other, and to produce both an agreeable variety of surfaces and of light and shade, much of the beauty and finish of a building depends.

Mouldings are distinguished by different names, according to their *profiles*, their sizes, or their situations. Thus the *fillet*, *tænia*, *band*, are all plane or flat mouldings, the only difference being that the first-mentioned is narrower than the others, and frequently is not so properly a distinct moulding as a space left between other surfaces, or else a rim to a larger moulding, as to a cymatium terminating a cornice, &c.; while *tænia* is the name given to the broad fillet separating the architrave from the frieze in the Grecian Doric entablature, and *band* is applied to any still broader plane surface—thus if instead of dentils, in an Ionic or Corinthian cornice, a projecting plane surface be left where they would occur, it is called an *uncut dentil band*. The *corona* (one of the principal members in every cornice) is also a mere plain band, except that it is occasionally enriched in Roman architecture. Again, lesser convex mouldings are termed *beads*, but the longer mouldings of the same kind in the bases of columns are termed *tori* or torusses. The *cyma recta*, or *cymatium*, is a compound moulding, concave above and convex below; while the *cyma reversa*, or, as it is technically termed by workmen, the ogive or ogee moulding, is convex below and concave above. The *cavetto* is a mere hollow or sweep, intervening between and serving to connect two mouldings, one of which projects beyond the other. The *scotia*, or hollow between the upper and lower torus of the base of a column, is a moulding of this kind upon a large scale, and has therefore a distinct name assigned to it, which also points out its situation. The *ovolo* is a simple convex moulding, so called because it is generally carved into *ova*, or ornaments in the shape of eggs, within hollows. The ovolo of the Doric capital (which is always uncut) is distinguished by the name of *echinus*. All the other mouldings may be carved or enriched, except the *cavetto* and *fillet;* the pattern being accommodated to the surface of the moulding. The cyma recta, or *talon*, as it is sometimes called, is cut with a peculiar kind of tongued or arrow-headed ornament.

These mouldings are common to both Grecian and Roman architecture, but besides being more profusely applied in the latter style they have this marked difference, that in Roman architecture the curved mouldings, whether simple or compound, are described by quarter circles, whereas in Greek they describe other curves obtained from conic sections, and are therefore not only more elegant in their contour, but susceptible of far greater variety. Some of them are also occasionally *undercut*, that is, hollowed out below and behind, whereby, while a greater depth of shadow is obtained, a greater sharpness of lines and lightness of form are produced. Of this kind is what is now distinguished by the name of the *bird's-beak moulding*, because its section produces an outline very much resembling that of the hooked upper and lower mandible in the beaks of some birds.

In Gothic mouldings, undercutting is very common, and hollows or recesses more or less deep are frequently numerous in the profiles of mouldings in that style. The mouldings are also for the most part produced by *splayed* or *bevelled* surfaces, that is, slanting or turned obliquely from the outer face or general plane where they occur. In that style the mouldings are so numerous, and the profiles produced by them so complex, as to render it impossible to describe or characterise them further. They are however of the utmost importance, both as adding greatly to the effect of buildings, and as assisting in the discrimination of the several styles or periods to which the buildings belong, and therefore require to be well studied and perfectly understood, for which purpose such works of detail as Pugin's 'Gothic Specimens,' and 'Gothic Examples;' Paley's 'Manual of Gothic Mouldings,' &c., may be recommended: the unprofessional reader will probably find sufficient information on the subject in 'Paley's Manual of Gothic Architecture,' Bloxam's 'Principles of Gothic Architecture,' or any of the other accepted guides to the study of Gothic architecture; see also the articles Gothic Architecture, and Norman Architecture. One circumstance however which ought to be mentioned is that the mouldings all recede within the face of the wall (like those of panels), except labels, hood-mouldings, and others, that come under the general denomination of *weather mouldings*, because made to project instead of recede, and therefore more exposed to rain and weather.

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* Delambre says that Riccioli confesses his argument to be a *subtlety:* but Delambre only knew the word as used in his own vernacular. A subtlety, before the word became one of reproach, meant a distinction requiring explanation, and was applied by Copernicans themselves to their own doctrine.

In regard to Grecian mouldings, it remains to be observed that many of those which are uncarved, and therefore supposed to have been quite plain, were painted with some ornamental pattern, and that not unfrequently in the most brilliant colours. But this mode of decoration is treated more at length in the article Polychromy.

MOUNTAIN BLUE. [Colouring Matters.]

MOUNTAINS. [Orography.]

MOVEMENT, in Music, a detached and independent portion of a composition. Symphonies, concertos, quartets, sonatas, vocal pieces of various kinds, &c., are divided into portions commonly differing from each other in time as well as in key, and every such portion is called a movement. Most symphonies are divided into an introductory slow movement, then a quick movement, an andante, a minuet, a trio, and another quick movement. The Pastoral Symphony of Beethoven, however, consists of five movements, namely, 1, a Country Scene; 2, The Rivulet; 3, The Village Dance; 4, The Storm; 5, as a *finale*, The Shepherd's Song.

MOVING FORCE may be defined as force considered with reference to the momentum it produces, in like manner as accelerating force means force considered as the cause of acceleration.

Apply continued pressure to a weight of 10 lbs., such as will in one second produce a velocity of 80 feet per second; apply another pressure to a weight of 7 lbs., such as will also in one second produce a velocity of 50 feet per second: the momenta produced in one second are then as 10 × 80 to 7 × 50, or as 800 to 350, and the moving forces are said to be in this proportion. The following equation is made the measure:—

$$\text{Moving force} = \text{mass} \times \text{accelerating force};$$

but this is on the supposition that a unit of acceleration produced in a unit of mass shall require the amount of pressure which is taken as the unit of moving force. [Mass; Momentum.]

The connection of momentum and acceleration are developed in Velocity and Virtual Velocities. It is necessary to remind the young student in mechanics that accelerating force is a mathematical abstraction, the conditions of all problems which actually occur introducing as data not accelerating forces, but moving forces. (See third law of motion, in Motion, Laws of.) Owing, however, to the problems which usually come earliest in mechanical treatises containing only accelerating forces among their data, or given laws of acceleration without reference to the masses in which acceleration is produced, or the pressures which produce them, the learner is not sufficiently reminded of this.

MOVING POWERS. The means employed to give motion to machinery, independently of the cases in which the force of gravity is applied directly, as in turning the cylinder of a clock, are the strength of men and animals, the pressure of the atmosphere, the expansive force of steam, and the action of wind or water. It is even possible that the recently proposed actions of the galvanic fluid and of fired gunpowder will in time be numbered among motive forces for impelling carriages, vessels, or machines. The first and second of the powers above named are treated under Animal Strength and Atmospheric Railway, and the force of steam under Steam-Engine.

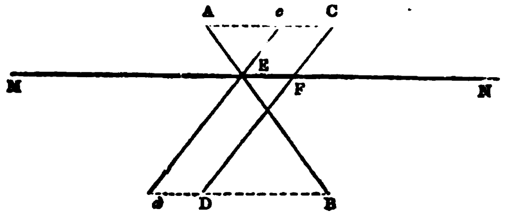
The intensity of a moving power is always estimated by the amount of the resistance which is overcome and the space through which the equivalent of that resistance is conveyed, or raised vertically, in a given time. Thus, in the article on Animal Strength, it has been shown that a man, a horse, &c., can convey a certain weight, expressed in pounds, through a certain number of miles during a working day; and the continued product of the weight, the distance, and the time has been made to denote the intensity of the power, one pound being the unit of weight, one mile that of distance, and one hour that of time: in estimating, however, the power of an engine or machine, it is usual to consider one foot as the unit of distance and one minute as the unit of time, one pound being the unit of weight; the action of the power is, moreover, supposed to be continued during all the time that the machine is at work.

Originally the larger kind of engines, except such as were impelled by wind or water, were moved by the power of horses; and when other agents were employed, the gross effect of the engine was estimated by the number of horses to whose action it was equivalent; but the intensity of horse-power is very variable, and some inconvenience was at first, on that account, experienced in estimating the relative values of engines. In order to establish, conventionally, this dynamical unit, Messrs. Boulton and Watt ascertained from trials, purposely made, that a strong horse can draw 125 lbs. at the rate of 3 miles per hour during 8 hours: therefore the measure of the power may be expressed by 3000 lbs. (= 125 × 3 × 8) drawn or raised 1 mile in 8 hours; or, multiplying by 5280, the measure is 15,840,000 lbs. raised 1 foot in an equal time. This product, being divided by the number of minutes in 8 hours, gives 33,000 lbs. for the weight carried or raised 1 foot per minute continually; and the last number is now universally adopted as a measure of the intensity of the power of a horse. Therefore, when an engine is said to have the power of any number n of horses, it is understood that it is capable of raising 33,000 n pounds' weight to the height of 1 foot in every minute during the continuance of its action. [Horse-Power.]

The method of estimating power by a weight carried or raised through a certain space in a certain time is capable of being applied to all engines: thus, in drawing a carriage along a road, the resistance of the carriage must be equivalent to some weight; and the reaction of the water against the paddles of a steam-vessel may always be represented by a certain weight which, if it were lifted by the wheel, would oppose a resistance equal to that of the water. For the useful force of steam-engines in terms of the volume of water evaporated, the pressure of the steam, the length of the stroke, &c., see Steam-Engine.

Wind and water are employed as prime movers by means of the momentum arising from their velocity; and the latter, occasionally, by the pressure arising from its weight. The manner in which the force of wind is made to act in giving motion to vessels on the surface of water will be fully explained under Sail, and in producing the revolutions of windmill sails under Wind-Sail; it is intended, therefore, in this place, merely to explain the method of forming an equation of equilibrium for the power of an oar in giving motion to a vessel, and to show the force of water on the paddles or float-boards of wheels which are turned by that element.

Let M N represent one side of a vessel, A B the position of the oar when its blade enters the water, and E the fulcrum or side of the row-lock against which it presses; then, since the vessel will move forward during the time that a stroke of the oar is being made, let F be the position of the fulcrum and C D the position of the oar at the end of the stroke: if the vessel had remained at rest, the oar, at the end of the stroke, would have had the position $c\,d$, which may be considered as parallel to C D.



Now, B being the centre of percussion on the blade of the oar, the actual motion of B (supposed to be parallel to the keel of the vessel) may be represented by B d while the movement of the vessel is E F (= D d); and therefore B D represents the relative movement of B. The lines B D and D d being proportional to the velocities of the oar and vessel, which velocities we may represent by v and v'; $v-v'$ will express the relative velocity of the oar, and the effective power of the latter will vary with $(v-v')^2$. Let a, in square feet, be the area of the blade of an oar, and let the pressure of water against a square foot of surface be $1\frac{1}{2}$ lb. when the velocity is 1 foot per second; then $\frac{3}{2}a\,(v-v')^2$ will denote the force of the oar.

If, for simplicity, the prow of the vessel be supposed to have the form of a wedge with plane faces meeting in a vertical line, or cutwater, on putting a' for the area of the whole prow and θ for the inclination of each face to a vertical plane passing through the keel, we shall have

$$\frac{3}{2}\,a' \cdot \sin.^3\theta \,.\, v'^2$$

for the resistance of the water against the prow. Therefore, n being the number of oars all of which are supposed to act with equal forces; we have, when the vessel has acquired a terminal velocity,

$$n\,a\,(v-v')^2 = a'\,v'^2 \sin.^3\theta,$$

from which v' may be found. The velocity of a vessel moved by oars is, however, found to increase in a less ratio than the number of oars.

The power of the oar in rowing appears to be diminished by the reaction of the feet of the rowers in pressing against the foot-boards; this has a tendency to force the vessel backwards, but it is compensated by the greater velocity which the centre of percussion in the oar thereby acquires. Some force, however, is lost in overcoming the inertia of the oar, and in bringing it forward against the air; this last force is considerable when the vessel is rowed against a high wind, though it is to a certain degree diminished by the practice of feathering the oars.

The above equation might be used to determine the velocity of a vessel impelled by steam, in which paddle-wheels are employed, if it were possible to determine, nearly, the value of na, or the number of square feet of paddle which, on both sides of the vessel, are at every moment acting efficiently against the water: the value of v would be, of course, determined by the number of revolutions which the wheel makes in a given time; and it should be expressed by the number of feet per second which the centre of percussion in the paddle moves through in turning about the axle.

The momentum of water flowing horizontally against a plane, such as a float-board of an undershot wheel, depends on its velocity, on the area of the surface with which it comes in contact, and on the obliquity of that surface to the direction of its motion; and in estimating the effect of water on such a wheel, it is necessary to determine from the dimensions of the channel and the velocity of the water in it the weight of water which descends vertically through a certain height, as one foot, in a given time. The product of this weight multiplied by the height actually descended, being compared with the product of the number of pounds which the wheel can raise to a certain height in the same time multiplied by that height, expresses the ratio of the power to the effect. From many experiments, Mr. Smeaton concluded that. when the quantity of water expended is the same, the useful result varies nearly with the head of water, or with the square of its velocity.

The power of an overshot wheel is estimated by the product of the weight of water expended in a given time multiplied by the whole weight of its descent—that is, by the sum of the diameter of the wheel and the height of water in the reservoir above the top of the wheel. The useful effect of an overshot wheel is said to be nearly double that of one which is undershot.

In determining the power of water on breast-wheels, it is customary to consider such a wheel as one compounded of an undershot and of an overshot wheel; and its effect is conceived to be equivalent to that of an undershot wheel whose head of water is equal to the difference in height between the surface of the water in the reservoir and the point at which the water impinges on the wheel, together with the effect of an overshot wheel whose height is equal to the difference between the point of impact and the level of the tail-water.

MOXA, a word of uncertain origin, signifying any substance whose gradual combustion on or near the skin is used for the relief or cure of disease. This method was early practised in the East, particularly by the Chinese and Japanese, from whom it was copied by the Portuguese; but having fallen into disuse, it was revived by the French surgeons during the Egyptian campaign. The substance employed by the Chinese is formed of the downy covering of the leaves of the *Artemisia Moxa* (De Candolle): but the down of many other plants, or the pith, may be used. The stalk containing the pith of the common sunflower (*Helianthus annuus*) is a very convenient means, when the prepared moxas cannot be procured. Those used in Britain are all imported from France, and generally consist either of a pyramidal or cylindrical roll of linen, which is mostly steeped in a solution of nitrate or chlorate of potass. The size of this is generally about eight lines high, and from four to five broad. It is ignited at the one end, and the combustion gradually extends to the other. This differs from the actual cautery by means of a red-hot iron, inasmuch as the latter produces immediately its maximum of effect, which progressively diminishes, while in the case of the moxa the heat gradually increases, and the greatest effect is produced towards the end of the operation. It is also different from a blister, both in its mode of action and in the stage of a disease in which it may be most advantageously applied. The general principles which should regulate the use of blisters having been already explained [Blister], as well as those connected with the actual cautery [Escharotics], the following observations refer to the distinctive characteristics of the Moxa. We may remark that the pain is not so great as might be expected, indeed less than often attends blisters, and that it is often borne by females and children, or at least boys, with the greatest fortitude.

Besides the secondary effects of the local application, which, being of a counter-irritative kind, are common to blisters and moxa, in the case of the latter there is the additional influence of a certain amount of caloric. "Caloric, applied under certain circumstances and with appropriate restrictions, stimulates in a powerful manner the capillary vessels, causing them to contract their diameters, and to circulate their blood with greater velocity; and, either by this action on the capillaries, or by a direct one on the lymphatics of the part, it has also the power of exciting the function of the absorbents in a remarkable manner. The direct effects of moxa are seldom, if ever, confined to the skin; and if the moxa be applied through the medium of a needle, the caloric may be made to propagate its influence to any depth. The beneficial influence of moxa, in relieving or curing disease, apparently depends on its tonic action over absorption and capillary circulation. Hence it should be employed in those cases only in which there exists a state of debility of the capillaries and a consequent retardation of their circulation, and a diminution of absorption; and invariably avoided wherever there is increased action or active inflammation."

To hold the moxa over the part affected, an instrument has been invented, but a portion of silver-wire formed into a loop, surrounding the cylinder near the base, is sufficient. The moxa may be applied in various ways. "It may be used so as not to cause any injury; in a greater degree, so as to produce vesication; and in a still greater degree, an eschar, which may be either deep or superficial; or it may be employed with the acupuncture needle." In the first form, it is burnt near, but not in contact with, the part affected, and is often of great service in healing indolent ulcers; it generally requires to be applied once a day. It is even used in some chronic inflammations of the eye with very good effect. In the second form it is also to be held near the skin, and continued till a blister results. In tic douloureux of very superficial nerves this is sometimes beneficial. The third mode is the most common, and for this the part to which the moxa is intended to be applied is marked out, and the moxa being surrounded with a piece of card-paper, which has been moistened with a solution of common salt, to protect the adjacent skin, the moxa is ignited at one end, and the combustion increased, if necessary, by means of a blow-pipe. For the cure of obstinate sciatica and deep-seated diseases of the joints a frequent repetition of the moxa may be required, but it seldom fails to give relief. "When the moxa and acupuncture needle are used together, a moxa of a proper size is to be perforated by a needle of such a length as will be sufficient to reach the seat of the disease, and at the same time extend so far from the surface of the skin as to keep the moxa about one inch from it. The needle is then introduced, and the moxa is now put in a state of combustion, and the heat disengaged from it is communicated to the needle, and thence conveyed to the seat of the disease." [Acupuncture.] When the pain from the third mode of applying the moxa is very great, a linseed-meal poultice, or liquor ammonia, will generally mitigate it.

Prejudice against this remedy, on account of its apparent severity, has prevented its being extensively used, but almost all practitioners who have made trial of it can attest its efficacy. It will rarely be had recourse to, except in cases of a neuralgic or paralytic kind of such obstinacy or painfulness as to justify the measure; but in such diseases it should not be overlooked. Its application has dispersed the almost ossified nucleus of a goitre, which resisted all other means to effect its absorption. (Wallace, *On the Action of Moxa.*)

MUCAMIDE ($C_{12}H_{12}N_2O_{12}$). This body is produced by adding ammonia to mucic ether. It is a white crystalline substance, very slightly soluble in boiling water.

MUCATES. [Mucic Acid.]

MUCIC ACID ($C_{12}H_8O_{14}, 2HO$). This acid is formed by the action of dilute nitric acid upon gum arabic, or sugar of milk, and some other bodies. One part of sugar of milk is heated with 4 or 5 parts of nitric acid diluted with half its weight of water; after effervescence has ceased, the liquid deposits mucic acid on cooling.

Mucic acid is a white crystalline powder, which is gritty between the teeth: its taste is slightly sour. It dissolves in 6 parts of boiling water, and the solution reddens litmus-paper. It is insoluble in alcohol, and dissolves very sparingly in dilute acids; it dissolves in concentrated sulphuric acid, imparting a crimson colour to it. When the mixture is heated, charcoal is developed. When submitted to dry distillation it blackens, and *pyromucic acid* and other products are obtained.

$$\underbrace{C_{12}H_{10}O_{16}}_{\text{Mucic acid.}} = + \; 6HO \; + \; 2CO_2 \; + \underbrace{C_{10}H_4O_6}_{\text{Pyromucic acid.}}$$

The alkaline mucates are soluble in water, whereas those which contain an alkaline earth, or a metallic oxide, are insoluble. These salts are all decomposed by the mineral acids: they combine with the base and set the mucic acid free. Boiled with water mucic acid yields the isomeric *paramucic acid.*

MUCIN. A proteic substance found in crude gluten.

MUCOVINIC ACID ($C_{16}H_{14}O_{16}$). An ethyl derivative of mucic acid, bearing the same relation to that acid as sulphovinic acid holds to sulphuric acid. [Ethyl.]

MUCUNA PRURIENS, or COWITCH, *the Medical uses of,* will be found under that head in Nat. Hist. Div.

MUDAR, the *Calotropis Gigantea* of Brown, and the *Calotropis mudarii* (Buch.), *Asclepias gigantea* of Linnæus. *Mudar* is a plant common in sandy places in many parts of India; it has a milky juice in its stem, which, as well as the bark of the root, enjoyed such reputation among the native practioners as a medicinal agent as to lead to its use among European practitioners in the East. It was found to be very efficacious in the cure of many obstinate cutaneous diseases, such as lepra Arabum and elephantiasis: in syphilitic complaints also and anasarca, it proved so valuable an alterative that it received the name of vegetable mercury. Some use the powder of the bark of the root, but Sir Whitelaw Anslie prefers the dried milky juice, which in a recent state, if taken in large quantity, is poisonous. It was thought to possess some specific quality, but Dr. Duncan, by whom extensive trials were made of it in Britain, showed that this is not correct, but that it is infinitely more valuable from its common medicinal properties, which correspond in every respect, according to him, both in kind and degree, with those of ipecacuan. He even thought that, from the facility with which any quantity could be procured from the province of Bahar, the use of the Brazilian ipecacuan might be altogether dispensed with in our East Indian settlements.

Besides its practical value as a medicinal agent, the bark of the root possesses the singular property in one of its constituents, *Mudarine,* of being very soluble in cold water, gelatinising when the solution is heated to 85° or 90° Fahr., and recovering its fluidity on cooling. It is almost the only instance known of any organic body being an exception to the general law of the power of solvents being increased by an increase of temperature, as most albuminous substances are solidified by heat. For this reason we here describe the mode of obtaining it, and give a brief sketch of its habitudes. Mudarine is obtained in a state of considerable purity from the tincture of mudar, by macerating the powder of the root in cold rectified spirit. The greater part of the spirit may be recovered by distillation, but the remaining solution, which acquires a much deeper colour though it remains perfectly transparent, is allowed to cool. As the temperature falls, a white granular resin is deposited by a species of crystallisation from a transparent coloured solution. The whole is allowed to dry spontaneously, in order that all the resin may concrete. The dry residuum is then treated with water, which dissolves the coloured portion, and leaves the resin untouched. It is to this principle, dissolved by cold water from the resinous extract, that the name Mudarine is given. It has no smell, and is intensely bitter, with a very peculiar nauseating taste. It is exceedingly soluble in cold water at the ordinary temperature of the atmosphere, but insoluble in boiling water. It is soluble in alcohol, but the power of this solvent is increased by increase of temperature. It is insoluble in sulphuric ether, oil of turpentine, and olive oil.

It is in the solution in water when nearly saturated that the peculiar property of Mudarine is most easily exhibited. At ordinary temperatures this solution is quite fluid and transparent. When heat is gradually applied, already at 74° Fahr., a change in its constitution begins to be observable, indicated by a slight diminution of its transparency. As the temperature is raised these changes increase, and at 90° it has in a great degree lost its transparency, and has acquired the consistence of a tremulous jelly. At 95° it is fully gelatinised, and a separation of it takes place into two parts, a soft brownish coagulum, and a liquid nearly colourless. At 98° the coagulum is evidently contracted in size. At 130° the coagulum seems to dissolve: at 185° the coagulum is very small, and has a tenacious, pitchy consistence. At 212° little further change occurs. The alterations which in this state it undergoes on cooling deserve to be noticed. At 140° the fluid is very turbid: the coagulum has not diminished in size, and is now very hard and brittle. At 110° fluid less turbid, coagulum remarkably brittle, with a resinous fracture: at 100° fluid more transparent. When cooled down even to the freezing temperature the coagulum remains unaltered, and very much resembles colophony; but after the lapse of several days it gradually liquefies in a portion of fluid in contact with it, without passing through the intermediate state of a jelly.

(Ainslie, *Materia Indica*, vol. i. p. 486; Duncan *in Edin. Med. and Surg. Journ.*, July, 1829; and in *Trans. of Royal Society of Edinb.*, vol. xi. p. 433.)

MUDARIN. The name given by Dr. Duncan to a peculiar principle obtained from the bark of the root of the *Calotropis Mudarii*, and to which he attributes its emetic effects. It is procured in the state of a brown, transparent, extractiform mass, by evaporating the alcoholic tincture of the bark. It is very soluble in water and in alcohol, but insoluble in ether, oil of turpentine, and fixed oils. Its aqueous solution gelatinises at 95° Fahr., coagulates at a higher temperature, and separates into a porous substance, which, when once cooled, does not redissolve for some days.

MUEZZIN, in Mohammedan countries, is the general appellation of those officers or clerks of the mosques whose duty it is to cry out from the minaret gallery the invitation to prayers, at the five canonical hours, namely, at dawn, at noon, at four o'clock in the afternoon, at sunset, and at night-close. The muezzin cry is a substitute for bells, which are not used in Mohammedan countries. The call is:—"God is great; I attest that there is no other God but God. I attest that Mohammed is the prophet of God: come to prayers; come to the temple of salvation. God is great; there is no God but God." Each of these sentences is repeated several times in succession, with pauses between, and in a kind of slow chanting, and occasionally shrill tone, forming a solemn though wild melody, peculiarly impressive, especially when suddenly breaking upon the silence of the night. On hearing the muezzin's call, the devout Mussulmans turn their faces towards Mecca, and recite their namaz, or prayers.

MUFFLE, a vaulted flat-bottomed earthen vessel in which substances may be strongly heated, and at the same time protected from the contact of the fuel; in this smaller vessels are placed containing the substances to be acted upon.

MUFTI, the general denomination of the head doctors of the law in Turkey, of religion and (where the law is founded on the Koran) of whom there is one in every large town. The mufti of Constantinople is the highest in rank, and has a jurisdiction over the muftis of the provinces, and also above the medressés, or colleges, and generally over the whole body of the ulemas, priests, or lawyers. He is styled sheikh ul islam, or "chief of the elect," and is consulted in important matters of law. He is appointed by the sultan, who can also depose him. His secretary, called fetwah eminé, has an office with about twenty clerks for the despatch of business. The dignity of sheikh ul islam is one of the principal in the empire, and is equal in rank to that of grand-vizir. His dress is of white ermine.

MUGGLETONIANS. [MUGGLETON, in BIOG. DIV.]

MULBERRY, BLACK, *Medical uses of.* The fruit (popularly, but incorrectly, termed a berry, being botanically a sorosis) of the *Morus niger*, is officinal in Britain. It is formed by a partial union of the enlarged and fleshy calices, each calyx enclosing a dry membranous pericarp. It is at first green, then red, and at last of a deep violet black, and contains much juice of a like colour. It has much mucilage, an astringent resin, sugar, which gives it a sweetish taste, an acid termed tartaric by some, malic by others. The officinal form is a syrup, to prepare which the fruit should be gathered before it is quite ripe. Tin or copper vessels, or any dish lined with either of these metals, should be avoided in making it—porcelain vessels are best. A vinegar, similar to raspberry vinegar, may be prepared with this fruit, which, like the syrup when mixed with water, forms a pleasant, cooling refrigerant drink in febrile diseases, or as a gargle in simple inflammatory sore-throat. But the syrup is chiefly used as a colouring ingredient. The fruit is susceptible of many other uses, economic and domestic. Too free indulgence in the fruit, even when fully ripe, is liable to cause diarrhœa. Many of the fruits drop from the trees long before they are ripe, and are apt to be picked up and eaten by children. No unripe fruit causes such severe griping. An emetic followed by rhubarb is necessary. The root of the mulberry is anthelmintic.

The wood of the *Morus tinctoria*, Linn. (*Broussonetia tinctoria*, Kunth; *Macluria aurantiaca*, Nutt.) contains a valuable colouring principle, which Chevreul has termed morin. The *Bois jaune* is the French name of this tree. (See Chevreul, 'Leçons de Chimie appliquée a la teinture.')

MULE; MULE-JENNY. [COTTON MANUFACTURE.]

MULIER. [BASTARD.]

MULLET. [HERALDRY.]

MULLION (by some supposed to be a corruption of *[illegible]*, from the Latin *munio*, to defend or strengthen), a term in Gothic architecture applied to the upright bars, or stone shafts, dividing the general aperture of a window into secondary openings, which are again in Perpendicular or Third Pointed windows frequently subdivided vertically by a similar shaft crossing the mullions horizontally, and therefore called a *transom;* whereby the whole space beneath the head of a window (supposing it to be an arched one) is formed into a series of pannels in which the glass is fixed, and which are sometimes technically distinguished as *lights* or *days*. Except in very small windows not exceeding in width one such *light* or compartment, mullions invariably occur in Gothic windows, being in fact absolutely necessary when no other mode of glazing was practised than that of small panes set in lead, because without some kind of strengthening or support, either by stone or metal rods, a spacious surface of the kind would be damaged by a strong wind, whereas each division becomes a separate window of no greater width than a single small one: consequently the number of the mullions depends upon the width of the window. Two-mullioned and three-mullioned windows are the most usual in ecclesiastical architecture, except for the large east or west windows in churches, and windows of nearly equal dimensions in other buildings. In these they are frequently very numerous; that, for instance, in the façade of York Cathedral is divided into eight lights or compartments by seven mullions, while that above the entrance to Westminster Hall has eight mullions. Again, the former of these is *untransomed*, but the other is *transomed*, being divided in its height to the spring of the arch into two tiers of arch-headed compartments; it also affords an instance of what is by no means uncommon in third pointed buildings of principal and subordinate mullions, being divided by two larger mullions into three leading compartments, each of which contains three smaller ones. The lesser or simple mullions, sometimes described as those of the *first order*, consist of the mouldings which run into and form the cusps where the heads of the compartments are foiled; while the larger ones have additional mouldings. In explanation of this we may refer to the window from Kirton Church, at col. 443, GOTHIC ARCHITECTURE, where the centre mullion is larger and composed of more mouldings than the other two, which have only those that form the cusps. As far as they go, the other specimens of windows given in that article will further exemplify the subject of mullions, and serve to render it evident that unless windows were so divided it would be impossible that their heads should be filled up with tracery.

MULTINOMIAL. [POLYNOMIAL.]

MULTIPLE, SUBMULTIPLE, MULTIPLICATION. Any number of *equal* magnitudes added together give a multiple of any one among them. Thus 4 + 4 + 4, or 12, is a multiple of 4. And submultiple is the inverse term to multiple: thus 12 being a multiple of 4, 4 is a *sub*-multiple of 12. The term submultiple is equivalent to ALIQUOT PART.

The derivation of the word is from multi-plex, mani-fold, and multiplication is the process of forming a multiple. Thus to multiply 184 yards by 279 is to repeat 184 yards 279 times, and to add all the results together. And this is the first and fundamental meaning of multiplication. Its usual symbol is × : thus 4 × 3 is 12.

If we look at the primary rules of arithmetic, we shall see that multiplication is the only one which cannot be entirely performed upon concrete quantities. To or from 100 yards 50 yards can be added or subtracted, and 100 yards can be divided by 50 yards; but 100 yards cannot be multiplied by 50 yards. The very definition of multiplication requires that every question should contain a number of *times* which another number, abstract or concrete, is to be repeated; and this number of times or repetitions cannot be a number of anything else. Thus, to talk of multiplying 10 feet by 7 feet is a contradiction in terms; if it mean that 10 feet is to be multiplied by 7, or that 7 repetitions of 10 feet are to be made, 10 feet is multiplied *seven* times, not *seven-feet* times. But if it be meant that 10 feet is to be repeated as often as 7 feet contains *one* foot, the question has three data, and belongs to a class which will be considered in PROPORTION: it is in fact a question of multiplication in which the number of repetitions is not given, but is to be extracted from the result of a question in division. On this subject see also RECTANGLE.

It being now distinctly understood that a number of times or repetitions is an essential element of every question of multiplication, the extension is obvious by which a fraction of a time, or a fraction of a repetition, is allowed to enter. Thus 12 + 12 + 12 + 6 is 12 repeated three times and half a time, or 12 multiplied by 3½ is 42. Similarly 2½ + 2½ + 2½ + 1¼, or 8¾, is 2½ taken 3½ times. Up to this point there is no violation of etymology; the *multiplicand* (*multiplicandum*, number to be multiplied) is taken manifold times. But [NUMBER] by the same sort of extension of language by which 1, and even 0, are called numbers, the mere exhibition of a multiplicand is called multiplying it by one: thus 7 is 7 taken once, or 7 multiplied by 1, though, etymologically, multiplication does not take place. Again, when the half of a number is taken, or when it is taken half a time, it is said to be multiplied by ½; and so on for any other fraction. The advantage of such extension in practice more than counterbalances its obvious defect, namely, that the beginner must, without great care, be confused by the application of a word in a sense diametrically opposed to its literal meaning.

The abbreviated process of multiplication rests upon the following principles. (1.) If the parts of a number be multiplied, and the results added together, the whole is multiplied; thus 18, composed of 13 and 5, is taken 7 times by taking 13 and 5 each 7 times, and adding the results. (2.) Multiplication by the parts of any number, and addition of the results, is equivalent to multiplication by the whole: thus 13 taken 7 times and 8 times gives two products, the sum of which is 13 taken 7 + 8 or 15 times. (3.) Successive multiplication by two numbers is equivalent to one multiplication by the product of these two numbers: thus 7 taken 3 times, and the result taken 4 times, is 7 taken as many times as there are units in 4 times 3, or 12 times. (4.) If one number be multiplied by another, the result is the same if the multiplicand and multiplier be changed: thus 7 times 8 is the same thing as 8 times 7. (5.) In the decimal system, the annexing of one cipher multiplies by 10, of two ciphers by 100, &c.

The application of these principles requires that, in the decimal system of notation, the products of all simple digits up to 9 times 9 should be remembered: this is usually done by learning what is called the multiplication table, and this table, which is only absolutely necessary up to 9 times 9, is usually committed to memory up to 12 times 12. This being supposed to be done, we shall now show the process of multiplying 1234 by 5073. By (2.) we must take 1234, 5000 times, 70 times, and 3 times, and add the results. To take 1234, 3 times, we subdivide it into 1000, 200, 30, and 4, each of which taken 3 times, and the results added together, gives

$$\begin{array}{r} 3000 \\ 600 \\ 90 \\ 12 \\ \hline 3702 \end{array}$$

from which process the rule for multiplying by a single figure may easily be derived. The next step is to take 1234, 70 times, that is, first 7 times, and the result 10 times. The full process is

$$\begin{array}{r} 7000 \\ 1400 \\ 210 \\ 28 \\ \hline 86380 \end{array}$$

Similarly 1234 taken 5000 times, gives 6,170,000. Now put the three results together, and add them; which gives the first column following:—

$$\begin{array}{r} 3702 \\ 86380 \\ 6170000 \\ \hline 6260082 \end{array} \qquad \begin{array}{r} 1234 \\ 5073 \\ \hline 3702 \\ 8638 \\ 6170 \\ \hline 6260082 \end{array}$$

The second column shows the usual manner of performing the operation, which we suppose the reader to know. We have given the preceding detail that he may do what many have never done, namely, compare the common process with the deduction of the result from first principles.

There are several abbreviations of multiplication which are very valuable, but which are not commonly taught.

1. Five times is half of ten times: to multiply by 5 annex a cipher and divide by 2: thus 76783 × 5 is most easily done as follows:—

$$\begin{array}{r} 2\,)\,\underline{767830} \\ 383915 \end{array}$$

2. Nine times is one less than ten times, so that 76783 × 9 can be found as follows:—

$$\begin{array}{r} 767830 \\ 76783 \\ \hline 691047 \end{array}$$

This may be best done by subtracting every figure of the multiplicand from the preceding, carrying and borrowing where necessary, in the usual way, on the supposition that the first figure is to be subtracted from ten. Thus the process of multiplying 27293 by 9 is as follows:—

$$\begin{array}{r} 27293 \\ 245637 \end{array}$$

3 from 10, 7, carry 1; 1 and 9 is 10, 10 from 13, 3, carry 1; 1 and 2 is 3, 3 from 9, 6; 7 from 12, 5, carry 1; 1 and 2 is 3, 3 from 7, 4; 0 from 2, 2.

3. Eleven times is one more than ten times; so that the addition corresponding to the preceding subtraction must be made. Thus to multiply 62781 by 11, proceed as follows:—

$$\begin{array}{r} 62781 \\ 690591 \end{array}$$

Let 1 remain; 1 and 8 is 9; 8 and 7 is 15, carry 1; 1 and 7 is 8 and 2 are 10, carry 1; 1 and 2 is 3 and 6 are 9; 6 and 0 is 6.

4. To multiply by any number from 12 to 19 inclusive, multiply by the last figure, and to the carrying figure add the figure of the multiplicand which is just done with. Thus—

$$\begin{array}{r} 2734 \\ 17 \\ \hline 46478 \end{array}$$

7 times 4 is 28, carry 2, adding 4, or carry 6; 7 × 3 is 21, and 6 is 27, carry (2 + 3 or) 5; 7 × 7 is 49 and 5 is 54, carry (5 + 7 or) 12; 7 × 2 is 14 and 12 is 26, carry (2 + 2 or) 4.

5. To multiply by 25, annex two ciphers and divide by 4: to multiply by 125 annex three ciphers and divide by 8.

6. In multiplying by a number of two figures, ending with 7 or 8, as 68, it may be advisable to take the multiplicand 70 times, and subtract it twice, in preference to taking it 60 times, and adding it 8 times.

The following rules are taken from the 'Risala Hisab.' (Taylor's 'Liliwati,' Introduction, p. 17.) The first at least can easily be done without paper.

1. To multiply two numbers together, each of which is between 11 and 19; to the whole of one number add the units of the other; ten times this, together with the product of the units' places, is the product required. Thus, 17 times 14 is 21 times 10 and 28, or 238.

2. To multiply two numbers together, each of which has only two places: to the whole of one factor, multiplied by the tens of the other, add the tens of that factor multiplied by the units of the other; ten times the result, together with the product of the units, is the product required. Thus 76 × 38 is done as follows: 76 × 3 is 228, which increased by 7 × 8, or 56, is 284, and 2840 increased by 48 is 2888, the answer required.

The multiplication of sums of money is facilitated by a process known by the name of PRACTICE.

The multiplication of fractions offers no difficulty when the extension of the word multiplication, already described, is understood and admitted. For instance, when we have to multiply ⅔ by $\frac{4}{11}$, or to take ⅔ 4-elevenths of a time, we see that ⅔ being $\frac{22}{33}$ [FRACTIONS], one-eleventh of this is $\frac{2}{33}$, and 4-elevenths is $\frac{8}{33}$: whence the rule commonly given, namely, multiply the numerators together for a numerator, and the denominators for a denominator. In the multiplication of one decimal fraction by another, as 1·23 by ·018, the multiplication of the numerators gives 123 × 18, or 2214, and that of the denominators 100 × 1000, or 100,000. But a decimal fraction which has 100,000 for its denominator, has as many places as there are in both of the others together, whose denominators are 100 and 1000. From this consideration the common rule immediately follows.

For a mechanical contrivance for expediting multiplication, see NAPIER'S RODS.

MULTIPLE POINTS. When two or more branches of a curve pass through the same point, it is called a multiple point; and this whether the branches touch or cut one another. When two or more branches intersect, it is obvious that as many distinct tangents may be drawn at the multiple point as there are branches which there intersect, that is, for one value of the abscissa the differential co-efficient of the ordinate may have more values than one. In most cases the points at which this happens may be ascertained by inspection of the equation of the curve. Thus in

$$y = (x-b \quad \sqrt{(x-a)}+c \quad b<a$$

$$\frac{dy}{dx} = \sqrt{(x-a)} + \frac{x-b}{2\,\sqrt{(x-a)}}$$

we see that y, in general, has two values, and so has $\frac{dy}{dx}$: to each value of the former belongs one of the latter. But in the single case of $x=b$, both values of y become equal, or y has only one value; while $\frac{dy}{dx}$ has the two values $+\sqrt{(b-a)}$ and $-\sqrt{(b-a)}$. There is then a multiple point when $x=b$ and $y=c$; and as *two* branches cut one another, it is called a *double* point. Similarly, had there been three, four, &c. branches, it would have been called a triple, quadruple, &c. point.

It is not worth while to enter here on the general method of determining double, &c. points. (See 'Lib. Usef. Kn.', 'Differential Calculus,' p. 182.)

MULTIPLICATION. [Multiple, &c.]

MUMMY, a name derived from the Persian and Arabic word *mom*, signifying wax; or even possibly contracted from the Greek word *amomom*, introduced into use about the 15th century, expressive of an embalmed or dried body, either of a man or animal, preserved, by resinous gums, wax, or salt, and even desiccation, from decay. The Egyptians themselves called such bodies *sahu*; and the word *Gabbara* used by St. Augustine (Serm. ccclxi, 12), is probably the hieroglyphic *kheper*, or "transformation," a term sometimes applied to the dead. The reason of thus preserving the body is involved in great obscurity, and its origin can be traced to the very earliest existence of the Egyptians. According to the classical authors, the welfare of the soul and its protection from the palingenesia, or transmigration, depended on the preservation of the body to which it returned after the accomplishment of its cycle of existence of 3000 or 10,000 years. (Servius ad Virgil. 'Æn.,' iii. 67.) The Egyptians had also great horror of the body being devoured by insects, or burnt by fire. It has been also conjectured that physical reasons may have introduced the custom, it being impossible to bury the dead in an alluvial soil annually flooded, or deposit them unembalmed in hills adjacent to cities, loading the air with infectious vapours. (Rosellini, 'Mon. Civ.,' iii. p. 310; 'Cassiodorus Coll.,' 15. c. 3.)

The hieroglyphical inscriptions throw some light upon Egyptian notions, showing that it was an object of solicitude that the soul should depart from earth, and that the body should remain or endure in its sepulchre. According to the sepulchral ritual (Lepsius, 'Todtenbuch,' taf. xxxiii., c. 89), the soul revisited the mummy, and if this wasted or decayed the soul immediately transmigrated. (Lepsius, 'Todt.,' taf. lxxv., c. 154.) In the moral nature of man, the hieroglyphical legends assert that the soul is the good and immortal principle, while the body is the bad and perishable (Rosellini, 'Mon. Civ.,' iii., p. 330); but every care was taken that physical means could devise, or theological ingenuity invent, to prevent the mortal frame from being destroyed. The corpse was embalmed after the model of that of Osiris; and the invention of the art was ascribed to his son Anubis, who first performed this office for his father. At Philæ the wall paintings represent the embalmment of Osiris; and other paintings in the tombs show the embalmers engaged in their occupation, the bodies ready for embalmment, the bandaging of mummies, and the preparation of the funeral equipment. (Rosellini, 'Mon. Civ.,' tav. cxxv.) The following were the rites of this art:—Immediately on the death of a person the relations, male and female, of the deceased raised throughout the city the funeral wail. The body, if a female, was retained a few days at home; those of males were delivered at once to the undertakers, called by the Greeks *Paraschistæ*, or "flank incisors," a polluted class, who were excluded from entrance into the temples, and even obliged to reside in the cemeteries or the suburbs of the great cities. (Strabo, xvii. 1145; Manetho, 'Apotelesm.,' vi. 549.) These *paraschistæ* had at the time of the Ptolemies the right of incising the corpses of particular districts, and several papyri attest their contracts or record their litigations. The principal Greek authorities (Herodotus, ii. 85, 87; Diodorus, i. 91) have given rather discrepant accounts of the offices of the *paraschistæ* and *taricheutæ*, but the following appears to have been the mode of embalming in their days. After the corpse had been transported to the establishment of the embalmers, a scribe drew with a reed on the left side, below the ribs, the line of the incision to be made by the *paraschistes*. One of that fraternity then, with an "Æthiopic stone," a kind of rude knife of flint or obsidian, made the necessary wound, and was immediately pursued by the bystanders with stones and imprecations, as if he had committed a heinous crime. Another of the embalmers, probably one of the class called *taricheutæ*, or "picklers," then proceeded to draw or remove the entrails and thoracic viscera, leaving only the heart and kidneys in the body. The viscera were soaked with palm wine and aromatic drugs; or, according to Porphyry ('De Abst.,' liv. iv., c. 10), the viscera were placed in a vessel and thrown, as the causers of impurity, into the Nile, after an appropriate prayer. Other embalmers, or *taricheutæ*, proceeded at the same time with the extraction of the brain, which was removed with a crooked instrument of bronze, resembling a catheter, through the nose, in order to deprive the body of the soft portions, which were most liable to decay, and enable them to confine their operations to the preservation of the skin and muscles. The subsequent operations depended upon the wealth and taste of the friends of the deceased. In the age of Herodotus three modes of embalming prevailed, models of which were shown by the *taricheutæ* in their shops to the relatives of the deceased. In the first process, which cost a talent of silver (about 243l. 15s.), used only by the wealthiest classes, certain drugs were introduced into the vacant cavity of the skull through the nostrils, the belly was bathed or rinsed with palm wine, and afterwards filled with powdered resins, cassia, and other aromatic drugs, and then the flank incision sewn up. After the body had been plunged into natron for 70 days it was wrapped up in linen bandages, anointed with gums which the Egyptians used instead of glue, finally placed in a wooden coffin, and set upright against the wall, either in the home of the deceased or in a mortuary chapel. For persons of more moderate means a cheaper process, costing only 20 minæ (81l. 5s.), was employed; the brain was apparently removed, but the *paraschistes* was not called in to make the flank incision, the viscera being injected with oil of cedar, and the body steeped in natron for 70 days, after which the viscera came away and the skin and bones only remained. The third process cost a trifling sum, not mentioned, and was used only by the poorer classes; the body was washed with myrrh, and salted for 70 days. (Herod., ii. 87. Diodorus, indeed, makes the period only about 30 days, but the longer period seems more correct.

When the body was finally prepared, the mummies were delivered to their families; but it sometimes happened that a considerable time elapsed before they were finally committed to the tomb, and they were till then retained at home (Cicero, 'Tuscul.,' i. 45; Tacit. 'Hist.,' v. 7; Mela, i., c. 9), and sometimes produced at festive entertainments (Lucian, 'de Luctu,' 21). Even as late as the days of St. Athanasius, A.D. 325, mummies were kept at home on couches (Athan. 'Vita Anton.' a custom which was reproved by the fathers of the church. (Damasc. Or. i. 'de Imag.;' St. Hieronym., vita St. Hilarion, c. 40.) During the period of their embalming and mourning the relations abstained from the use of the bath, of wine, and of delicate food, and arrayed themselves in mourning or coarse garments. When finally committed to the sepulchre, the mummies were confided to the care of the Cholchytæ, a class of priests of higher rank than the *taricheutæ*, or embalmers; they were deemed a respectable fraternity, admitted into the temple, and enjoyed the privilege of sanding the floor. (Peyron, 'Papiri Greci,' i. p. 62.) It has been supposed that they wrapped the mummies in linen bandages, after the model of Osiris (Athenagoras, 'Legat. pro Christ.' 2. Damasc. in 'Phot. Bibl.' cod. ccxli.; Suidas, '*voce* Heraiskos'), but this is hardly probable, as females belonged to the class. (Peyron, 'Papiri Greci,' 1827, ii. p. 48–64.) They rather appear to have inhabited the Thynabouna, and the Memnoneia, or necropolis on the western bank at Thebes, and to have been engaged in celebrating the funeral masses of the mummies, to which certain emoluments were attached, and which they sold with the houses they occupied and the mummies under their charge. Many papyri contain their plaints: one, A.D. 127, records the injuries and thefts perpetrated by resurrectionists on the funeral paraphernalia of their mummies to the amount of about 28l. or 7[illegible] (Letronne, 'Nouvelles Annales,' i. p. 273; Kosegarten, 'Bemerkungen ueber ein Ægypt. Text. eines Papyrus,' 4to, Greisf. 1824); and it appears from the document that the doors of the sepulchre had been left open and the mummies themselves become the prey of prowling jackals. The mummies were sent in funeral barges or *baris* down the Nile to their sepulchres, the poorer shipping them on board the public vessels and merely attaching to them a tessera or ticket of wood; while richer individuals hired a private *baris*, and despatched a messenger with a letter describing the private marks on the bandages by which they might be recognised. (Peyron, B., 'Papiri Greci,' p. 40.)

Not only were the bodies of the Egyptians thus embalmed, but those also of persons who died in the country were subjected to the same process. One of the earliest embalmments on record is that of the patriarch Jacob, who was prepared in this manner for 40 days (Gen. l. 3.) Joseph was also, according to the rabbinical writings, embalmed and buried either in the bed or on the banks of the Nile (Gen., l. 26; Isaiah, lxv. 4.) The body of Alexander the Great was embalmed with honey (Statius, 'Silv.,' iii., 2, 116), and existed at Alexandria till the age of the Emperor Severus, and was seen and handled by Augustus on his visit to that city. (Dio., li. 16. The bodies of Antony and Cleopatra were embalmed in the Egyptian manner, and deposited in the same sepulchre, and that of the unfortunate queen was subsequently found entire by the Emperor Heraclius ('Epist. ad Sophocl.') Embalmment was also the right of the poorest Egyptians, even of malefactors; and those who were injured by crocodiles were treated with remarkable honour, and buried at the expense of the nearest city. The Æthiopians, according to Herodotus (iii. c. 24), embalmed in nearly the same manner as the Egyptians; they appear to have coated the body with lime, and to have placed it in a sarcophagus of glass or some other transparent substance, and after keeping it about a year in their houses, and offering and praying to it, to have finally placed it outside the city.

It is clear that in the space of more than 2000 years the mode of preparing mummies must have greatly differed, and that individual caprice must have been often exercised in so empirical an art. The older writers (Lanzon., 'de Balsamatione,' 12mo, 1693) divided them into six kinds, but the more recent observers have considered the art as:—1. Drying the bodies in the sand, chiefly employed for the poorer classes (Magnus, 1, 'das Einbalsamiren,' p. 26; Belzoni, 'Discoveries,' p. 170); 2. Salting in natron, and then drying; 3. Boiling in resins and bitumen; 4. Preparing with fine resins, and removing the brains and viscera. A division, purely arbitrary, has been made between mummies having the flank incision, and those without. Of the 1st class they make:—1. Those prepared with an aromatic resin, having the skin like tanned leather, sometimes partially gilded; 2. Those prepared with bitumen, the skin hard and shining like Japan varnish, the body filled with bitumen, the mummy difficult to unrol. Of this class some are salted and then daubed with resinous substances, others with pitch, having the skin hard and smooth. The mummies without the flank incision are either salted and prepared with impure masses of bitumen, or salted only; the first kind have their form utterly destroyed, being covered with a mass of pissasphalt which has penetrated through the skin, muscles, and bone, owing to their having been boiled or suffused with bitumen. They are hard, and give forth a pleasant smell, and they chiefly come from Sakkara, and date from the 7th to the 2nd century, B.C. The salted mummies are usually in bad condition, the skin like parchment, and easily broken. Some anomalous examples have been found prepared with wax, and in those prepared by pissasphalt the skin has been sometimes removed. (Magnus, 'das Einbals. d. Leichen,' p. 26-27.)

Great difference of opinion exists about the substances employed, *natron* or *litron* is supposed to be Glauber's salts, common salt, saltpetre, or soda (Dioscorides and Galen), kedrion, or oil of cedar, turpentine, or pyroligneous acid (Pliny, 'N. H.' xvi, c. 21; Lösch, 'die ægypt. Mum.' 12mo. Nurenb. 1827.) Asphalt came from the Lacus Asphaltites of Idumæa (Diodor., xix. 99; Strabo, xvi. 526), the pissasphalt was a mixture of the same substance with pitch. Myrrh and cinnamon (the bark of the Laurus cassia, (Herod., ii. 87; Magnus, p. 33.) The *syrmæa* was an alkaline preparation. All these materials have been found in different mummies, either within or without the bodies, and some mummies have been found strewn with the drier materials, such as myrrh, cinnamon, and cassia, which retained their fragrance. (Osburn, 'Leeds mummy,' p. 6.)

Considerable difference prevails as to the treatment of the various portions of the body: the brain was generally removed through the nose, or orbits of the eyes, or base of the cranium. The cavity of the skull when removed is found sometimes hollow, at others filled with pissasphalt, or earthy matter. The nostrils are generally plugged with linen pads to exclude the entrance of the air, or of destructive insects, which nevertheless have sometimes penetrated the skull and body. The eyes have sometimes been removed and the cavities filled with artificial ones of ivory and obsidian or coloured porcelain. The hair of men has generally been left in its natural condition, but that of females has often been cut off, wrapped up in separate linen bandages, and deposited either in the coffin, or placed on the body. Sometimes these masses of hair are made up in an oval shape and covered with bitumen, at others merely folded in linen. The flank incision varies in position and length, being placed in some mummies beneath the ribs, but in others under the arm-pits. This incision in mummies of the 26th dynasty, and under the Ptolemies and Romans, has a square rectangular thin plate of tin, on which is incised in outline the right symbolical eye, emblem of the sun, in accordance with the 140th chapter of the Ritual. (Lepsius, 'Todt.,' taf. lvii. c. 140.) The entrails, which have been removed through this incision, have been treated in different manners, according to the care with which the embalmment has been performed, or the epoch at which the body has been mummied. At all epochs the most costly funerals had four large jars of zoned, alabaster, calcareous stone, terra cotta, porcelain, or wood modelled in shape of the four genii of the dead,—Amset, Hapi, Tuautmutf, and Kabhsenuf; mummied, and having the heads of a man, ape, jackal, and hawk. The thoracic and abdominal viscera were divided into four portions, embalmed in accordance with the process employed for the body, either by immersion in natron, or boiled in asphalt, made up into oval or cylindrical packets which are enwrapped in linen, and one portion deposited in each jar. On the day of the funeral these jars were placed in a large box and transported on a sledge to the sepulchre, and finally arranged at the side of the coffin or under the sepulchral bier. The most elegant and costly jars have formulæ reciting that the four principal goddesses, Neith, Selk, Isis, and Nephthys, watch over and protect these embalmed portions. In mummies of a later period, where so much cost was not expended, the embalmers made the viscera into four oval packets, and either placed them on the body, or returned them through the flank incision into the body, in which case they are usually accompanied by figures of red, yellow, or dark wax, or earth coated with that substance, representing the four genii. On a mummy opened at Jersey (Pettigrew, 'Archæologia,' vol. xxvii. pp. 262, 273), the portions attached to *Amset* were the stomach and large intestines, *Hapi* presided over the small intestines, *Tuautmutf* the lungs and heart, *Kabhsenuf* the liver and gall bladder. Mummies of the 26th dynasty have sometimes the fingers enclosed in stalls of silver, in order to prevent injury to the nails when the epidermis was destroyed, and the body subjected to the boiling bitumen into which the body was immersed (Birch, 'Archæol. Journ.,' viii. 278); and in the days of the Ptolemies and Romans, the tips of the nose, the nails, and extremities, and even portions of the flesh were gilded, supposed by some to be those parts where decay had commenced, or lesion appeared. (Gryphius, 'Mum. Wratisl.' 12mo. 1662; Fabricius, 'Biblogr. Antiq.' c. xxiii. i, c. 7.) One particular custom, not Egyptian but Greek, is found on mummies of the Ptolemaic and Roman period—the jaws are carefully closed and bound up, while in those of the Pharaonic age the mouth is always open. (Cailliaud, 'Voyage à Meroe,' iv. p. 13, and foll.) The mummy of Petemenophis-Ammonios, found by Cailliaud at Gournah, was discovered to have the eyelids closed by a plate of gold in shape of an eye with its lid, and a plate of gold in shape of the tongue over that member, while a crown of gilded copper encircled the head. (Cailliaud, pl. lxxi.) On the Wratislaw mummy, a plate of gold of 10 grs. weight was found under the tongue. (Gryphius, p. 46.) The limbs are differently disposed, the legs, however, always straight and extended; the hands of women are sometimes crossed upon the breast, and of girls on the groin; those of men and women are often placed flat down the sides, with the palms inwards and fingers extended. (Cailliaud, 'Voy. à Mer.' iv. 13; Passalacqua, 'Cat.' p. 180.) Various small portions of the body, such perhaps as had become diseased, were embalmed separately in the same manner as the viscera, and placed in recesses hollowed in the pedestals of wooden figures, in shape of Osiris, or Ptah Socharis. (Rosellini, 'Mon. Civ.,' tom. iii. p. 349). The hieroglyphical Ritual gives directions for various amulets to be placed about the body, the most remarkable of which are a scarabæus of hard stone inscribed on the base with the 26 or 64 ch. found on rich mummies on the breast; or when plain, sometimes discovered inside the body: this was to protect the heart. Another in shape of the index and middle finger is often found in the belly. (Pettigrew, 'Hist. Eg. Mum.,' pl. iv. 5 p. 96; Herzog., Pl., fig. 34.) The other amulets, chiefly disposed on the neck, are a pillow of hematite, emblems of life, of stability, symbolic eyes, and figures of deities strung as a necklace round the neck. Nineteen were found on the Jersey mummy, and seventy-four on that of Gotha. Plates of tin incised with the winged disk, or the flying hawk, and other symbols, have been found on the chest. Besides these amulets, the jewellery worn during life, the ear-rings, bracelets, finger-rings, collars, and other valuables, have constantly been found. (Herzog, 'Mumiogr.' p. 16.)

The bandages of mummies are invariably of linen, the use of wool being prohibited. (Herod., ii. 37.) The only woollen bandages discovered were those of the supposed body of Menkheres, and of the workmen of the Tourah quarries, rendering the age of these bodies uncertain. Neither cotton nor silk, as conjectured by some of the older writers, was ever used. (Thompson, 'Mummy Cloth,' Class. Mums. vol. vi. p. 152.) The greater part of these bandages were made of old linen, either collected by the deceased during his life-time or else by the *taricheutæ*. Shirts and darned portions of garments are frequently found, and even the initials of the deceased embroidered on the cloth. This cloth is of various qualities, from the coarseness of canvas to the fine texture of muslin. The mass of bandages are, however, strips of about three or four inches wide, and from one to several yards wide, wound round the form with great skill and symmetry, and apparently laid on in a wet state. All the inequalities are carefully padded with small pledgets to bring the body to a symmetrical shape. At the Roman period, the limbs are bandaged separately, showing their form, in narrow strips of linen. The bandages near the form were often laid on while the asphalt was still hot and liquid, and others were dipped in liquid aromatics before applied; but the greater part are of linen once white, but which has become of a cinnamon or yellow colour through age, although capable of resuming their original colour when bleached. Some pieces of linen have selvages, fringes, and blue lines, produced in the woof by threads dyed with indigo, as if torn from the original piece, and large shrouds which cover the other bandages close to the surface have been dyed of a red colour by means of the *Carthamus tinctorius*. The length of these bandages is considerable, as much as 1000 ells having been found wrapping a single mummy. Wrappers bandaging mummies are represented in Rosellini ('Mon. Civ.' cxxvi.). The mummy when thus prepared exhibited only the general outline of the human form, and lay like a great chrysalis in its cocoon. The name of the deceased, the years that he lived, and the reign of the monarch in whose reign he died, are sometimes found inscribed in a caustic ink, said to be nitrate of silver, on the inner bandages of some mummies. These marks are supposed to have been made in the shops of the wrappers, to prevent mistakes in the re-delivery of the bodies to the families. The bandages are generally of coarsest linen near the body, and of finer quality outside.

On some mummies, prepared with the greatest care, straps of a scarlet leather, about one and a half inch wide, have been found crossing the shoulders, the ends crossing on the breast, on the ends of which are stamped, apparently by a heated metal-punch like that used by the bookbinders, the names and titles of the reigning king, or the monarch adoring Amen-Ra. The earliest of these bears the name of Rameses XIII., of the 20th dynasty (Osburn, 'Mummy at Leeds,' pl. 2), and they continued to be used till the age of the Psammetici, B.C. 525. At the Roman period leaden and wax seals were sometimes attached to cords passed through the bandages of mummies, but the reason of the custom is unknown. (Pettigrew, 'Hist. Eg. Mum.,' pl. xi. 3.) The interior bandages of mummies have frequently a case composed of as many as twenty or forty layers of linen closely pressed and glued together, and then covered with a thin layer of lime, on which have been painted in tempera the face and dress of the mummy, various deities connected with funereal rites, and vignettes and texts of chapters from the Ritual. A certain order attends these drawings—a scarab is often painted on the head, a flying ram-headed hawk on the chest, the goddess Nu on the stomach; and at the feet, sometimes made of a piece of board, the enemies of Egypt painted under the sandals, or the bull Apis bearing on its back a mummy. These cartonages, which are found on the mummies of the kings of the 11th dynasty, continue till the Ptolemies. Under the Roman empire they were replaced by a large painted sheet, on which was painted the deceased or Osiris, and some sepulchral deities, or by the portrait of the deceased painted upon thin boards of cedar in encaustic. These later paintings cease to preserve the conventional Egyptian style, but represent the deceased with Greek features and costume. Beneath these cartonages is found a network of blue porcelain bugles, deities, and pectoral plates, and sometimes beaded work well executed, and they are externally ornamented with wreaths of artificial or real flowers, and tinsel. The cartonage has often the same pedestal as the mummy-case, showing that the body was set upright during the funeral ceremonies. The colours employed, and the style of painting of this sepulchral ornament, is very different in different mummies and at different periods.

Sometimes instead of a cartonage the external linen bandages are covered with extracts, more or less copious, from the Ritual of the Dead, traced in black carbonaceous ink, a style of ornamentation which prevailed both at an early and recent period, having been found on the coffin of a monarch of the 11th dynasty, and on mummies of the Ptolemaic period. Figures of deities and other representations taken from the sacred books are also traced on the bandages. Papyri were often deposited with the mummies generally rolled up, and in the inner bandages sometimes unfolded and spread over them, rarely in the hands, as in the case of a Greek mummy exhumed at Thebes, which held in its hand a papyrus containing the 17th book of the 'Iliad.' These relics were, however, often placed in wooden figures of the gods Osiris and Phtah Sochtaris. These papyri are chiefly rituals or other religious books of a sepulchral nature. Besides papyri, little mummied figures, called 'the workmen of Hades,' made of stone, porcelain, clay, or wood, were deposited in the tombs in little wooden boxes, to help the deceased in his agricultural labours in the Elysium. Around them is inscribed the 6th chapter of the Ritual.

The mummies in their cartonages were deposited in coffins of sarcophagi, generally of wood, either of cedar or sycomore, made in the shape of a mummy with its pedestal. Persons of high station and wealth sometimes had as many as three of these wooden coffins each increasing in size so as to fit into one another like a nest of boxes. Those of kings were deposited in an outer sarcophagus of hard stone in shape of a chest or bin. Such outer coffins are of the greatest rarity, and at the early period of the pyramids are either entirely plain or only ornamented with architectural ornaments, but in the age of the 18th and following dynasty are covered with inscriptions and intaglio reliefs representing the passage of the sun through the hours of the day or night. Some of these stone sarcophagi, especially those of the later dynasties, are in the form of the mummy. The inscriptions of those of the 26th dynasty are often the 72nd chapter of the Ritual; the stone coffins of the Ptolemaic age have the same principal deities of the Pantheon addressing the departed as Osiris, and other formulæ. The wooden sarcophagi are of different shapes at different ages—that of the king Menkheres, builder of the 3rd pyramid, is of cedar, uncoloured and in the shape of a mummy—those of the 6th & 11th dynasties are often rectangular chests painted inside with representations of wardrobes, and inscribed with copious extracts of funeral rituals.

The coffins of mummies from the 18th to the 26th dynasty are made in shape of the human form swathed, are principally sycomore covered with a ground of white stucco, and painted with various deities and hieroglyphics in tempera. Their style of art differs at each period, and vignettes of the 89th and 125th chapters of the Ritual are often seen amongst the paintings, at a later period the 99th chapter is sometimes found. The paintings of coffins of the 21st dynasty are often of a yellow colour, owing to the copious employment of varnish which has assumed this colour through age. This style of coffin apparently continued till about the 1st century, B.C. when a new shape was introduced, the body being laid upon a flat board over which is placed a vaulted cover, having at each corner a square upright post, resembling a dish cover. The paintings on these coffins are the Great Judgment, c. 125 of the Ritual; in the interior are figures of the heaven, and Greek and Egyptian zodiacs. Those of later periods were probably of the same shape, but ruder in their art; owing to the expense few mummies comparatively were placed in coffins, those in the public cemeteries being found piled in tombs one above another, while others are laid in layers of reed or charcoal, and some bodies are found buried in the sand. The tombs of the Egyptians are generally hollow rock chambers excavated in the hills of the Arabian chain to the west of the principal cities, but sometimes, as at Sakhara, in tombs hollowed in the plains. The principal sites where mummies are found are at the bournah quarter of Thebes and in the plains of Sakhara. Few mummies of children have been found. The number of mummies made from the commencement of the Egyptian monarchy till the cessation of the art in the 7th century has been calculated to have been 420,000,000. Owing to the changes which have taken place even in times of remote antiquity, when the Cholchytæ trafficked in tombs and bodies, it often happens that the mummies and coffins do not correspond, the names of the old occupants having been erased for the new occupants, and the Arabs and other dealers have often placed mummies in the cases sent to Europe which do not belong to them (Birch, 'Epochs of Mummies' in Gliddon's 'Otia Egyptiaca,' p. 78-87; Passalacqua, 'Catalogue,' p. 181. Several mummies exist in the different collections of Europe, and reference to the principal ones described will be found in the works cited in this article.

In unrolling mummies, the cartonage or outer covering should, when necessary, be carefully divided vertically from head to foot in order not to destroy the interesting paintings with which it is covered, and the bandages unwound with care, every one being carefully examined to see all the peculiarities which may occur. The body itself requires a medical autopsy. Deception has been occasionally practised, many fictitious mummies made by Arabs or Levantine traders having been detected by Blumenbach. ('Observat. on Mummies,' Phil. Trans,' 1794.) In the 15th and 17th centuries, the pissasphalt and other resinous substances which exuded from mummies were employed as a drug called mummy, the Genoese and Venetians extensively imported mummies into Europe for the shops of the apothecaries, and the charlatans of the day obtained from mummies oils, extracts, and elixirs, antidotes of all poisons and nostrums against all diseases. Francis I. always had this universal remedy about him.

The Egyptians applied the art of embalmment to the preservation of the bodies of the sacred animals, so extensively worshipped throughout Egypt from an early period of the monarchy, although they did not bestow upon them so much care as on the human mummies. The mummies of apes, cynocephali, the living emblem of the god Khons, have been found in catacombs at Thebes, prepared by natron and resins, and adjusted in a squatting, not extended form like human mummies. A dog, living emblem of Anubis, has been found mummied at full length, and some were enwrapped in cartonages. Large numbers of cats, sacred to Bast, chiefly in the extensive catacombs of these animals at Busiris, have been found, some in bandages made up into the form of the animals; others of conical shape with the legs close to the body, and the head modelled in linen, and others placed in coffins of wood or bronze made in the form of small statues of the animal, with their pedestals in shape of the hieroglyphic name of the goddess to which it was sacred. It was embalmed according to Herodotus (ii. 88.) with kedria.

Wolves' mummies have been found at Lycopolis. The larger animals were only partly embalmed, the principal bones being made up into a kind of rude trunk of the animal, the head and skull carefully preserved, the bodies wrapped in papyrus or palm-leaves, and the eyes, nostrils, and diacritical marks of the sacred bulls Mnevis of Thebes and Apis of Memphis being worked in a dark or coloured cloth on the outer bandages. Sometimes their mummies have been made up in shape of a minotaur. The Apis was also in some instances embalmed with bitumen and placed in huge coffins of stone in the vicinity of the Serapeium. [Serapeium.] Mummies of rams or lambs, sacred to Ammon, &c., prepared by natron, and bandaged in the same manner as the sacred bulls, have been found at Thebes, and also the heads of a small gazelle *leucoryx*, treated in the same way, with bitumen. Mummies of the sacred vultures of the goddess Mut, and different kinds of falcons sacred to the sun, made up into the form of a mummied deity, with the hawks' heads modelled in linen, and the body covered by a neat network of thin linen strips, have also been found at Thebes; the owl, emblem of Buto, and the swallow have also been discovered. But the bird most commonly embalmed was the ibis, sacred to Thoth, extensive catacombs of it mummied existing at Sakhara, and some pits of the same at Thebes. Its mummy is made in the shape of a heart, the head and neck beneath the left wing, and the beak the length of the body. According to Ælian (Nat. An., x., c. 29), it was embalmed in natron: the analysis of the materials shows them to have been salt, oil, pitch, and aromatic resins. (Langguth 'De Mumiis Avium.,' 4to, Vitteberg, 1808.) The eggs of this bird, and parts of its food, have been found with it; but in most instances, apparently owing to heated applications, it has almost entirely perished. At Sakhara the mummies are found in stone, glazed ware, or terra cotta cases, or cones with convex covers, cemented with lime, and piled in the catacombs; at Hermopolis its mummy is placed in oblong cases of wood or stone; and at Thebes only in its envelopes. Some rare instances represent it bandaged as a human seated body, with an ibis head. The sacred goose of Seb also occurs. Numerous mummies of the sacred crocodile of the god Sebak have been found at Ombos, Eileithyia, principally at Manfaloot, and Thebes. They are prepared with bitumen, cemented, and wrapped in palm-leaves and papyrus, having coarse outer bandages of linen. The serpent tribe are embalmed in packets in shape of an oblate egg, sometimes as many as six in one packet, the whole neatly and tightly packed with pink and yellow bandages, or single instances deposited in bronze cases in shape of the reptile on a pedestal. Lizards have been found in cases of the shape of the reptile; two species of fish, the cyprinus and the silurus, and also scarabæi, prepared by natron, and wrapped in linen bandages.

Nations of antiquity attempted to preserve the human form after death, but they can scarcely be considered mummies. The Persians used wax (Herod., i. 140; Cicero, 'Tusc.,' i. 45); the Assyrians honey (Strabo. xvi.), and the Jews embalmed their kings Asa and Zedekiah with spices (2 Chron., xvi. 14; Jerem., xxxiv. 5). The body of our Lord was anointed with spices (John, xix. 39, 40). Aristobulus was preserved in honey (Joseph., xiv., c. 7); and Alexander the Great was embalmed with wax and honey (Statius Silv., iii. 2, 117). The Romans occasionally—as in the case of Poppæa (Tacit., 'An.,' xvi. 6)—embalmed the body, and bodies so prepared have been found near the Appian Way and at Albano. Certain bodies have been found dried by the effects of natural situations, as the corpses of the Spaniards and Mexicans fallen in fights (Humboldt, 'Ansicht der Natur.,' 12mo, Tub. 1808, p. 509); those frozen by cold in the morgue of the convent at St. Gothard (Gannal, 'Hist. d'Embaum.,' p. 53); others discovered in 1785 in the church of the Innocents at Toulouse (Puymaurin, 'Acad. de Toul.,' 1787; Magnus, 'Das Einbals.' p. 15); at Bourdeaux; in the cloisters of the Capuchins at Palermo (Smyth, 'Sicily,' p. 88); those in the vaults of St. Michan's Church at Dublin; that of Aurora, Countess of Königsmark, at Quedlinburg, others at Haliar, and at Strasburg, &c. Embalmed bodies of monarchs of the middle ages and of the last centuries have been occasionally found.

The only people who adopted a mode of preserving the body like the Egyptians are the Guanches, the ancient inhabitants of the Canary Isles. These bodies, called *xaxos*, had the viscera removed through a flank incision made by a stone called *tabona*. The belly was then filled with absorbent vegetable powder and salt; a salve of goats'-fat, the rind of figs, pitch, pumice, and a kind of euphorbium, and the *Chenopodium ambrosioides* were used in the preparation, which was continued for 14 days (Bory St.-Vincent, 'Essai sur les Isles Fortunes,' 4to, Paris, 1807, ii., p. 56; Magnus, 'das Einbals.' p. 71), the body being dried in the sun or by a stove. When thus prepared, the mummies, adjusted in a squatting position, were sewn up in sheep or goat skins; those of the poorer classes being joined together in one envelope, while those of the richer were placed in their dress *tamarco* in cases hollowed out of savine wood, and placed under a kind of pyramid. The bodies are not bandaged, but are excessively light, being quite dried and tanned, with a slight aromatic smell; the features are distorted, and not well preserved. Numerous catacombs are found filled with them, and as many as 1000 were discovered at Teneriffe. (Humboldt and Bonpland, 'Reise,' 12mo, Wien., 1825, i., 225.) On the American continent, probably owing to the greater dryness of the air, preserved bodies have been found, as at Durango, Bogata, and those of the Coroados Indians on the Paraiba River, in the Brazils, the bodies of whose chiefs, deposited with their ornaments and favourite animals, in a couching posture, in large covered jars, are long preserved. (Debret, 'Voy. au Bresil,' i. 19.) Several dried bodies of the ancient Peruvians, wrapped up in coloured cotton bandages, have been found at Arica and other places in Peru; but their preservation is due to the lightness of the soil and the air, and not to any artificial process. In the South Sea, at Nukahiwa, bodies have been temporarily preserved for a few months in cocoa-nut oil (Langsdorf, 'Reise um die Welt,' i. 208); and the Birmese know how to keep the body for a short time by means of pitch *dhamma*; but such processes scarcely render the body a mummy. It is not necessary here to detail the modern processes employed for the preservation of the body for museums of anatomy and natural history, as such embalmed bodies are in no sense mummies, and the European climates are too unfavourable to permit their preservation except under circumstances of peculiar care. The subject of mummies has been treated by many authors since the commencement of the 16th century. The principal works treating of the subject in general are—Pettigrew, 'History of Mummies,' 4to, Lond., 1834; Gannal, 'Traité d'Embaumement,' 8vo, Paris, 1838; Philadelphia, 1840; Magnus, 'das Einbalsamiren der Leichen,' 8vo, Braunsch., 1839.

MUMPS, an inflammation of the parotid, and often, at the same time, of the other salivary glands, of contagious or epidemic origin. The inflammation, and the fever by which it is accompanied, generally increase for about four days, and then begin to subside; and after four days more, the disease is commonly at an end. The affection has a tendency to metastasis, that is, to pass suddenly from the organ first affected to some other. The treatment required is very simple; quietude, abstinence, seclusion from cold, the application of poultices or other warm substances, or, in severe cases, of leeches to the swelling, are all the means that are usually necessary.

MUNICIPAL CORPORATIONS. A municipal corporation, as at present understood, may be defined to be a body politic formed for the purpose of local government. Other bodies politic or corporate exist for the advancement of religion, learning, or commerce. The municipal corporation is concerned with the regulation of the social and financial affairs of a town, or limited body of citizens. The origin of such bodies in this country may be traced to the times of the Roman occupation, that people having planted *municipia* or town-communities in this island, as in other parts of their dominions.

The Anglo-Saxons appear to have adopted these institutions, finding them entirely congenial to their previous customs, and, in fact, their municipal organisation was not confined to the towns or fortified cities alone, but pervaded the whole territory, which was divided into districts in the management of the affairs of which every freeman had a vote.

The Norman kings endeavoured to effect a centralisation of political power by substituting *bailiffs* of their own in the place of the elective *borough-* or *port-reves*, who during the Saxon times presided over the various town communities. To rid themselves of the oppression of these officers, the towns offered to pay a larger revenue to the king's exchequer, than was extracted from them by the bailiffs, provided they were allowed to collect it themselves. Thus the right of self-government was gradually repurchased from the crown, the obnoxious title of bailiff being in most cases done away with, and that of *mayor* adopted to designate the chief officer of a town.

For several centuries after the Conquest, a select body or corporation in the more modern sense of the term, within and distinct from the township itself, was unknown. The chief object of the Norman sovereigns in granting to the burgesses or townsmen the right of electing a chief magistrate of their own, was to obtain punctual payment of a stipulated rent, and to insure at the same time in each locality as much internal peace and order as was requisite to enable the community to perform this stipulation with exactness. The municipal body consisted of the resident and trading inhabitants, paying scot and bearing lot, that is, sharing in the payment of local taxes and the performance of local duties. Strangers residing temporarily in the town for purposes of trade had no voice in its affairs, as they incurred no liability to its burdens. Birth, apprenticeship, or marriage within the township, were titles to citizenship, as evidences of the essential requirement of established residence. Titles by purchase were obtainable by individuals not previously connected with the community, or who were permanently resident elsewhere. In many of the greater towns, the subdivision of the general community into *guilds* of particular trades, called, in many instances since the Norman era, *companies*, opened up avenues for admission to the general franchise of the municipality. In their greatest prosperity these fraternities, more especially in the metropolis, were important bodies, in which the whole community was enrolled; each had its distinct common-hall, made by-laws for the regulation of its particular trade, and had its common property; while the individuals composing them, as members of the great general community, remained the same.

In course of time, and after the practice had arisen of the towns sending representatives to take counsel with the king in parliament, it became the policy of the crown to give a more distinct entity to the governing powers in the various boroughs, and to form close bodies, irresponsible to the general community. In most cases, by an arbitrary stretch of power, the various guilds were dissolved, and their property confiscated and transferred to the newly-constituted corporation. Such bodies were found to be infinitely more manageable than the freemen, and by their means a great influence was obtained by the sovereign in the appointment of representatives. This policy was pursued by the princes of the Tudor line, and was continued and improved upon by the Stuarts. The right was first assumed of remoulding by *governing-charters* the municipal constitution of certain boroughs, which had either ceased to send representatives to parliament or had never exercised that privilege, but upon which this right was now conferred. Most of these charters vested the local government, and sometimes the immediate election of the parliamentary representatives, in small councils, originally nominated by the crown, to be ever after self-elected.

The next step was to claim the same power over municipalities which had always exercised the right of sending representatives. The ignorance or subserviency of the law courts in the reigns of Elizabeth and James I. favoured this design. In the 12th year of the latter monarch, it was judicially declared that the king could by his charter incorporate the people of a town in the form of select classes and commonalties and vest in the whole corporation the right of sending representatives to parliament, at the same time restraining the exercise of that right to these select classes; and such was thenceforward the form of all the corporations which royal charters created or re-modelled.

The perversion of municipal institutions to political ends, the sacrifice of local interests to party purposes, the alienation of corporate property, and other flagrant abuses flowing from the whole powers of the corporations being vested in select bodies, had for more than two centuries been a matter of constant and nearly universal complaint before a remedy was applied by the statute 5 & 6 Will. IV. c. 76, commonly known as "the Municipal Reform Act," but of which the title is, "An Act to provide for the regulation of Municipal Corporations in England and Wales." Upon this Act a number of others have since been grafted, by which various special objects of municipal government are provided for, the whole together constituting a most beneficial code, of which the full results still however remain to be seen. We will endeavour to state succinctly the nature and rules of the existing municipal corporations under the Act 5 & 6 Will. IV. c. 76.

These corporations consist of a mayor, aldermen, and burgesses, by which names they have perpetual succession.

Burgesses.—The qualifications of a burgess, the want of any one of which is fatal to the claim to that appellation, are as follows:—The burgess must be a male, and of full age. He must be found on the last day of August in any year to have occupied a house, warehouse, counting-house, or shop within the borough during that year and the whole of the two preceding years. He must during that period have been an inhabitant householder within the borough or within seven miles of it. He must be duly enrolled on the burgess-roll for that year; and to be entitled to enrolment, he must have been rated to the relief of the poor during such time of occupancy for his premises within the borough, and must have paid on or before the last day of August in that year all poor rates and all borough rates (if any) payable by him in respect of such premises, except such as become payable within six calendar months before the said last day of August. He need not during the period in question have continued to occupy the *same* premises. Disqualifications are, being an alien, having been convicted of bribery, and having within twelve months next before the said last day of August received any parochial relief, alms, or charitable allowance.

It is the duty of the overseers of the poor to prepare a list of the burgesses every year, which is to be delivered on the 1st of September (20 & 21 Vict. c. 50, s. 7) to the town clerk, who causes copies to be printed and sold, and fixes a copy on the door of the town hall from the 8th to the 15th of September. This affords an opportunity for all persons who claim to be inserted in the burgess-lists, if they find their names omitted, to assert their rights, which must be done by giving notice of their claim to the town clerk on or before the 15th of September. In the same way, objections may be raised to names supposed to be improperly inserted. Lists of the claims and objections made are framed by the town clerk and fixed up on the door of the town hall from the 23rd of September to the 1st of October. A court for the revision of the burgess-lists is held by the mayor and two borough assessors between the 1st and the 15th of October. The claims and objections are heard, and upon the evidence given the mayor inserts the names of those who establish their claim, and expunges the names of those against whom an objection is successfully maintained. Any other mistake, as the insertion of the name of a dead person, may also on this occasion be corrected. The mayor's decision as to the rejection of any name from the burgess-list is under the control of the Queen's Bench; and under 7 Will. IV. & 1 Vict. c. 78, persons whose claims have been rejected, or whose names have been expunged, may apply for a mandamus to have their names placed on the burgess-roll.

The burgess-lists, when revised, are reduced by the town clerk into alphabetical order, and entered in a book, each name being numbered. This book is the *Burgess-roll;* it must be completed on or before the 22nd of October, and every person whose name is found in this roll is entitled to vote at elections of councillors, assessors, and auditors of the borough from the following 1st of November until the 1st of November in the succeeding year.

Councillors.—On the 1st day of November in every year (or if it be Sunday, then on the following day) an election of councillors takes place. The number of councillors is various in different towns. When a town is divided into wards, each ward elects its own councillors. The qualifications for the office are these:—The candidate must be on the burgess-roll for the current year; and, in case the borough be divided into four or more wards, he must be possessed of property to the amount of 1000*l.*, or rated to the poor of the borough upon an annual value of not less than 30*l.* If the borough be divided into less than four wards, it is sufficient if he be worth 500*l.*, or rated to the poor upon an annual value of not less than 15*l.* No person in holy orders nor regular dissenting minister can be elected, nor any one holding any office in the gift of the council, except that of mayor; nor one having any interest in any contract or employment with, by, or on behalf of the council. Conviction of bribery at a municipal election also constitutes a disqualification. The recorder of the borough is prohibited from being a member of the council. One-third of the whole number of councillors go out of office every year, according to seniority of election, so that the office is held by each councillor for three years.

Aldermen.—The number of aldermen is one-third of the number of councillors. One half of the whole number of aldermen go out of office every third year, being those aldermen who have held the office for the longest time without re-election. The places of the outgoing aldermen are supplied by the council, who, on the 9th day of November, elect the necessary number of persons from the council or from amongst the burgesses who are qualified to be councillors. An outgoing alderman may be re-elected. Every alderman may be called upon once in three years, upon the requisition of any two members of the council, to make and subscribe a declaration that he is qualified to the same amount in real or personal estate, or both, as the amount mentioned in the declaration originally made by him.

In case of the death of the mayor, or his incapacity to attend to his duties, one of the aldermen may be temporarily chosen by the council to supply his place. Aldermen are also chosen by the councillors in each ward to preside at ward elections. Every alderman is a member of the council during his tenure of office. In other respects the functions of the alderman do not differ materially from those of the councillor.

The Mayor.—The mayor is elected on the 9th day of November in every year, by the council, out of their own body, consisting, as we have seen, of aldermen and councillors. The outgoing mayor may be re-elected. In case of a vacancy occurring during the year, a new mayor must within ten days be elected, who holds office for the remainder of the current year. The council may award the mayor an allowance or salary. The mayor takes precedence in all places within the borough, and during his year of office and the succeeding year is a justice of the peace. He presides at all meetings of the council, and may call meetings as often as he pleases. He may appoint an alderman or councillor to act as his deputy during his illness or absence, which deputy, however, cannot *ex officio* act as a justice of the peace, or preside at any meeting of the council unless appointed by the meeting to do so.

Auditors.—Two auditors for the borough are elected by the burgesses on the 1st of March in each year. The mayor also nominates an auditor on the same day. The elective auditors are elected from persons qualified to be councillors; the mayor's auditor must be a member of the council. The duties of these officers are to examine and audit the borough accounts half-yearly.

Assessors.—Two assessors for the borough are elected by the burgesses on the 1st of March in every year, whose duty it is to assist the mayor in the revision of the burgess-lists. If the town be divided into wards, two assessors are also annually elected for each to preside with the alderman of the ward at ward elections.

Town Clerk.—This important officer is appointed by the council, and holds his office during pleasure. The council may award him a salary, and he must not be a member of the council. He may be, and in fact usually is, an attorney. All the charters, deeds, muniments, and records of the borough, or relating to the property thereof, are placed in his charge and custody, under the control and direction of the council.

Treasurer.—This officer is also appointed by the council, and holds office during pleasure. He may receive a salary, and must not be a member of the council. The offices of town clerk and treasurer cannot be united in one person. The treasurer keeps the borough accounts, and makes and receives all payments from or to the borough fund.

Other Officers.—The council also appoints a clerk of the peace, and a borough coroner in boroughs having a separate court of quarter sessions; and they may also appoint such other officers as have been usually appointed in the borough, or as they shall think necessary. The offices of recorder, borough justices, and police magistrates, when such are required, are in the appointment of the crown.

Declarations and Oaths.—Under the statute 9 Geo. IV., c. 17, every person elected to the office of mayor, alderman, town clerk, or common councilman, or to any office of magistracy, or place of trust or employment relating to the government of any city, corporation, borough, or cinque port within England and Wales or Berwick-upon-Tweed, must, one calendar month before or upon his admission to office, make and subscribe this declaration:—

"I, A. B., do solemnly and sincerely, in the presence of God, profess, testify, and declare, upon the true faith of a Christian, that I will never exercise any power, authority, or influence which I may possess by virtue of the office of ——— to injure or weaken the Protestant Church as it is by law established in England, or to disturb the said Church, or the bishops and clergy of the said Church, in the possession of any rights or privileges to which such Church, or the said bishops and clergy, are or may by law be entitled."

The statutes 1 & 2 Vict. c. 5, 1 & 2 Vict. c. 15, and 8 & 9 Vict. c. [illegible] by a slight alteration of this declaration (omitting the words "upon the true faith of a Christian"), have adapted it to the scruples or religious differences of Quakers, Moravians, Separatists, and Jews, so that members of all these persuasions can be elected to municipal offices in common with their fellow-citizens.

No person elected mayor, alderman, councillor, auditor, or assessor for a borough can act as such without first making a declaration before two or more aldermen or councillors, to the effect that he will faithfully fulfil the duties of his office according to the best of his judgment and ability, and that he is possessed of the amount of property required as a qualification, over and above what will satisfy all his debts. A person duly elected to the office of mayor, alderman, councillor, auditor, or assessor, is bound either to accept office or to pay a fine to the borough, not exceeding 100*l.* in the case of mayor and 50*l.* in the case of the other offices mentioned, as the council by bye-law shall determine. Lunacy, imbecility, deafness, blindness, or other permanent infirmity of body are valid grounds for exemption from serving and from the fine. Military, marine, and naval officers of her Majesty on full pay are also exempt, and any person above the age of 65 years, or who has already served or paid a fine for non-acceptance of office within five years from the time of re-election, may claim exemption, provided they make the claim within five days after receiving notice of their election.

Functions and Duties.—All acts of the corporate body are ratified by the annexation of the common seal, which expresses the assent of the whole body. The council, consisting of the mayor, aldermen, and councillors, is the acting organ of the general body, and the business of the borough is transacted at its meetings, general and special. Under the Municipal Corporation Act, three clear days' notice of every meeting, signed by the mayor, must be fixed on or near the door of the town hall. In case of the death, resignation, or removal of the mayor, the town clerk must sign the notice of the meeting to be convened in order to fill the vacant place of mayor. Quarterly meetings for the transaction of general business are appointed to be held, one at noon on the 9th of November (or the next day if that be Sunday), and the other three upon such days as the council shall at that meeting appoint. No notice of the business to be transacted at these quarterly meetings need be given.

The mayor may call a special meeting as often as he thinks proper. Should the mayor refuse to call a meeting, when requested so to do by writing signed by five members of the council, those five members may call a meeting, of which they must give due notice, and which they must sign, stating at the same time the business to be transacted. A summons to attend, specifying the business to be transacted, signed by the town clerk, must be left at the abode of every member of the council three clear days before every special meeting; and no business save that specified in the summons can be transacted at the meeting. At every meeting the majority of members present decides all questions, provided the whole number present be not less than one-third of the whole council. The mayor, or in his absence such alderman, or if no alderman be present such councillor, as the rest shall choose for chairman, presides, and in case of equality of votes has a casting vote. Minutes of the proceedings are drawn up and entered fairly in the minute-book, and must be signed by the chairman at the meeting. These minutes are open to the inspection of any burgess at all reasonable times on payment of a fee of one shilling.

The council may appoint out of their own body committees for general and special purposes, whenever it is thought that the matter in question can be better managed by means of a committee. The acts of all committees must be submitted to the council for approval.

The council may make bye-laws for the good rule and government of the borough, and for prevention and suppression of such nuisances as are not already punishable in a summary manner by virtue of any Act in force throughout the borough, and may appoint such fines, not exceeding 5*l.*, as they may deem necessary to enforce the observance of these regulations. Such bye-laws, however, have no force until the expiration of forty days after a copy sealed with the common seal has been sent to one of the secretaries of state, and has been affixed to the door of the town hall or some other public place within the borough, and such bye-laws may be annulled or modified by the crown with advice of the privy council.

Police.—It is the duty of the council to appoint out of their own body a committee entitled "The Watch Committee," for managing affairs of police within the borough. This committee appoints constables, who may act within seven miles of the borough, and who are empowered to apprehend idle and disorderly persons disturbing the public peace, or whom they may reasonably suspect to intend felony, and to deliver such to the constable in attendance at the nearest watch-house. The watch committee must transmit a quarterly report on the 1st of January, 1st of April, 1st of July, and 1st of October, to the secretary of state, with a copy of their rules for the management of constables.

Paving, Lighting, &c.—By the Municipal Corporation Act, and by 6 & 7 Will. IV. c. 105, and 20 & 21 Vict. c. 50, provision is made for the transfer to the body corporate of the borough of the powers for paving, lighting, supplying water, and other useful objects, which under a multitude of local acts had been previously vested in the old corporations or in separate bodies of trustees. Charitable trusts, of which the old corporations were the depositaries, are not transferred to the councils, but have been confided to distinct bodies of trustees.

Borough Fund.—The rents and profits of all hereditaments, and proceeds of all personal property, dues, fines and penalties, and moneys arising from the sale of copies of the burgess-roll, overseers' lists, and lists of claims and objections, are directed to be paid to the treasurer of the borough, and constitute the borough fund. The council are restrained from alienating or mortgaging lands or granting leases (except leases not exceeding 31 years without fine), unless with the consent of three lords of the treasury. An exception is made, however, with regard to certain leases renewable by custom, and building leases.

The purposes to which the borough fund is applicable are, the payment of the salaries of the mayor and other officers, all the expenses attending the preparation of the burgess-list and municipal elections, the expenses of the prosecution and punishment of offenders, the maintenance of the borough jail and other public buildings, and various other municipal expenses. Certain contributions are also required to be made to the county treasurer for public purposes; and other expenses to be presently referred to, have been charged by sundry Acts of Parliament upon the borough fund.

If the borough fund be more than sufficient for all the purposes defined by law, then the surplus is to be applied, under the direction of the council, for the public benefit of the inhabitants and the improvement of the borough. Should the borough fund be insufficient for the above-mentioned purposes, the council are empowered to levy borough rates for the purpose of supplying the deficiency.

The treasurer keeps accounts of receipts and disbursements, and the account books are open to the inspection of any alderman or councillor. They are audited half-yearly, in the months of March and September, and after the September audit a full abstract is printed and published. A full statement of accounts is sent to the secretary of state before the 1st of March in every year.

Justice.—With regard to the administration of justice in boroughs under the Municipal Corporation Act, the crown is empowered to appoint, in the boroughs named in schedules A and B of that Act, justices of the peace, who are not required to have any qualification of estate. The council also of every borough may, if they think it necessary that one or more salaried police magistrates should be appointed, make a bye-law fixing the amount of salary, and thereupon the crown may appoint a barrister of five years' standing to the office. The appointment is vested in the crown, in order that the administration of justice may be above the suspicion of being tainted by party or local interests, which might be incurred if the appointment was made by the town council. In boroughs where the council signify their desire to that effect by petition, setting forth the grounds of their application, the state of the jail, and the salary which they are willing to pay, the crown may appoint a recorder for any one such borough, or for two or more conjointly. He must be a barrister of not less than five years' standing.

Prisons.—In every borough to which a separate court of sessions of the peace is granted, there must be one common jail, and at least one house of correction, excepting where the corporation contract for the maintenance of borough offenders in some county or borough jail, or house of correction, or in some district prison. The regulation of the jail is entrusted to the borough justices, for which purpose they hold a quarterly session at the usual times of holding quarterly sessions of the peace.

Lunatic Asylums.—The Lunatic Asylums Act, 1853, directs that in every borough having a quarter sessions, recorder, and clerk of the peace, or having had at the passing of a previous Act (8 & 9 Vict. c. 126, 8th Aug., 1845) six justices or more, besides a recorder, a pauper lunatic asylum be provided or hired. The justices of the borough may contract with the justices of any other counties, boroughs, or hospitals, for the reception of the borough lunatics, or they may contract for the erection and provision of a joint lunatic asylum, for the reception of lunatics of other places, as well as their own borough. The charges of the asylum are thrown upon the borough fund, or, if necessary, upon a general borough rate levied for the express purpose.

Public Libraries and Museums.—The Public Libraries Act, 1850, authorises the mayor, upon the request of the town council of any municipal borough, the population of which at the last census exceeded 10,000, to take the sense of the community as to the desirability of putting this Act into operation. A poll of the burgesses is held after a ten days' notice, and if two-thirds of the votes are in its favour the Act is adopted. The Act enables the council to purchase or hire the necessary lands and buildings, and to erect and maintain necessary buildings, and for this purpose to levy a rate, which must not exceed in any one year one halfpenny in the pound on the annual value of the property in the borough rateable to the borough rate.

The council, and committees appointed by them, are authorised to make rates for the conduct of the museum and library, and the appointment and salaries of officers. Admission to such libraries and museums is to be free of all charge. The council may, with the approbation of the Treasury, borrow money on security of the rate levied under this Act.

Public Baths and Wash-houses.—The 9 & 10 Vict. c. 74 (1846), which is intended to encourage the establishment of public baths, wash-houses, and open bathing-places, may be adopted by the council of an incorporated borough, and may then be carried into operation in accordance with the existing laws and regulations relating to the borough. The expenses may be charged upon the borough fund or supplied by a separate rate. The council have the control and regulation of the baths and wash-houses thus established. They are also empowered to raise money for the purposes of the Act upon security of the borough fund.

Public Health Act, 1848.—This important Act, which is directed to the promotion of the health of towns and populous places, by the supply of water, and the improvement of the sewerage and draining, may be brought into operation in boroughs upon the petition of not less than one-tenth of the inhabitants rated to the poor, or without this in places where it can be shown from the registrar-general's return that the annual number of deaths exceeds 23 in 1000. A report having been made to her Majesty by the General Board of Health upon the case, the Act is put in force by an order in council. But in cases where a local Act of Parliament for cleansing, water supply, &c., is in force, the order in council must be ratified by Act of Parliament before it takes effect. In districts consisting solely of a corporate borough, the council of the borough are constituted the local board of health; in larger districts, including more than a borough, the mayor and a portion of the councillors are to be members of the local board of health formed for the united district.

Nuisances Removal and Diseases Prevention Act, 1848.—In places where the Public Health Act is not in force, the council of the borough may, upon the receipt of a notice signed by two inhabitant householders of the existence in any house or premises of a privy, cess-pool, or other nuisance dangerous to health, cause the premises to be examined; and if satisfied of the dangerous nature of the nuisance, either by such examination or the certificate of two medical practitioners, the council may lodge a complaint with a justice, who may summon the owner to appear, and order the nuisance to be removed within two days. In default of this being done by the owner, the council may themselves cause the nuisance to be removed, and recover the costs against the owner or occupier.

Public Buildings, &c.—Powers of building, enlarging, or repairing town halls or council houses, police offices, borough jails, or houses of correction, are imparted to the councils of boroughs by the Acts 7 Will. IV. & 1 Vict. c. 78, and 5 & 6 Vict. c. 58 & c. 98. They are empowered to borrow money and to purchase land for such purposes. Bridges within the limits of the borough, and which are repaired at its expense, are placed under the management of the council.

The number of Acts affecting more or less directly municipal corporations in England and Wales, commencing with the Municipal Reform Act (5 & 6 Will. IV. c. 76) up to the present time is not less than sixty; and the reader must be referred to special treatises upon the subject for more minute information. (See Blackst., 'Comm., vol. i., p. 515, Mr. Kerr's ed.; Rawlinson's 'Municipal Corporation Act;' Merrifield's 'Burgesses' Manual.')

In Ireland the municipal system was amended by the Act 3 & 4 Vict. c. 108 (1840), the provisions of which resemble in many respects those of the English Municipal Reform Act. In Scotland, by the Acts 3 & 4 Will. IV. cc. 76 & 77, the constitution of the common councils in such burghs as had formerly possessed bodies of this kind was reformed, and councils were conferred upon such burghs as had previously had none.

MUNICIPIUM, a term which properly denotes, according to its etymology (*munus* and *capio*), the capacity of enjoying rights with the liability to duties. It is however used in the ancient Roman writers to express a class or body, the members of which are called Municipes.

Municipium, as a collective name for a number of individuals, had different significations at different periods of Roman history. In its oldest sense, it signified those inhabitants of Italian towns which had a league or treaty with the Roman state, by which the citizens of such towns, though not Roman citizens, enjoyed, when at Rome, all the privileges of Roman citizens, except the suffrage and the eligibility to the honours of the state (magistratus), and were also subject to the burdens of Roman citizens; the Fundani, Formiani, Cumani, Acerrani, Lanuvini, and Tusculani, are mentioned as examples. A Roman jurist (Servius, the son) says that municipes originally signified those who became citizens, their own state remaining perfectly distinct from and unconnected with the Roman state, and who were not allowed to attain to the dignities of the Roman state. (Fest. Epit., 'Municipium.')

A second class of municipes is defined to be those whose State had become a part of or was blended with the Roman state, as was the case with the inhabitants of Caere, Aricia, and Anagnia. (Festus, 'Municipium.') But this would appear to be a misapplication or improper application of the term, inasmuch as this class of municipes comprehended those who ceased to have a State of their own, but were incorporated with the Roman state on such terms as the latter chose to grant.

A third class is defined (but the definition is somewhat obscure) to comprehend those towns which received the Roman citizenship, and at the same time became municipia: Tiber, Praeneste, and other towns are cited as examples. Niebuhr observes that the places mentioned in this third class were either "all Latin colonies or Italian towns, such as by the Julian Law, or by those which followed and gave it a wider application, became municipia in the later general sense." It seems to be clear from this definition that municipium must here be understood not in the sense which it has in the first definition, but in the later sense of a town called a municipium. For the first part of the definition gives to the municipes of this class the full Roman citizenship; and the second part adds (what might very well have been understood without the addition) that the towns included in this definition must have had a local administration. These towns in effect became integral parts of the Roman state, having before been separate, and as a necessary consequence their local administration, which must still have subsisted, became subject to the general Roman law, instead of being independent of it. Such towns were the municipia of the Imperial period. The definition of municipes by Paulus is, "those who are natives of the same municipium." Ulpian, who also (D. 50, i. 1.) gives the same definition of municipes, refers to the *original* signification of the term: "muneris participes recepti in civitatem ut munera nobiscum facerent." He adds: "but now, by an abuse of the term, municipes is the name given to the citizens of any particular town, as for example, a Campanus or Puteolanus. He who is born of a Campanian father and mother is therefore a Campanian: if his mother be of Puteoli, he is still a Campanian municeps, unless by some special privilege (privilegium) he is a municeps of his mother's city, a favour which is granted to some cities."

It appears then that the municipium, as an ancient Roman institution, may be defined generally as the communication of the rights of Roman citizens (and as a consequence, their liabilities) to Italian towns by treaty or agreement. It thus resembles the isopolity (ἰσοπολιτεία) of the Greeks. It is easy to conceive that the rights thus conferred might be either the complete rights of Roman citizenship or only part of such rights. After the freedom of the city was extended to all Italy, and subsequently to the provinces, there was no essential difference between a colonia and a municipium, though the origin of their connection with the Roman state was very different. [COLONY.] Thus, under the emperors, all the inhabitants of the same town, whether it was a colonia or a municipium, might with propriety be called municipes, notwithstanding the criticism of Gellius (xvi. 13).

Under the emperors we find various towns in the provinces, as in Spain and Britain, which were erected into municipia. The members of these towns were Roman citizens, and administered the affairs of their own community, subject to the general laws by which all Roman citizens were bound. A municipium had a corporate character, under which all the municipes, that is, all the members of the city, were comprehended. It would appear as if the decuriones were sometimes considered as the corporate body representing the municipium. The municipium could sue and be sued, and could acquire and hold property. The decuriones were the senate or council of a municipium; and the two chief magistrates were called duumviri. The municipia had also other local magistrates; and many of them had a mint, as we see from their extant coins. Thus the later municipia of the empire were in all respects like modern corporate towns, of which they were undoubtedly the origin and the type.

It follows from what has been said, that an Italian town was originally called municipium, or the inhabitants municipes, solely with reference to the participation of the townsmen in the privileges of Roman citizens, and that under the republic such municipia were in all respects independent of Roman law in their internal organisation. The municipia included in the third definition, and the later municipia erected under the emperors, were improperly so called, inasmuch as the inhabitants of these towns became, or were, Roman citizens, and in all respects subject to Roman law.

The original signification of municipium in the old Roman constitution is discussed by Niebuhr ('Roman Hist.,' vol. ii.) in an instructive chapter, which contains all the necessary references. It is not easy, however, to assent to all this writer's opinions.

For a more extensive inquiry into this subject, the reader may consult F. Roth, 'De re municipali Romanorum;' Savigny, 'Gesch. d. R. R. im Mittelalter,' t. i. c. 2; and Heineccii 'Antiquitat. Roman. Syntag. App.,' lib. i., cap. v.

MUNIMENTS. This word is a derivation from *munio*, which signifies "I defend," and originally designated those writings in which are recorded the transactions of former times, out of which existing relations, in respect of political rights, social rights, or property, arise. Hence, by showing their origin, they *defend* the possession of them by those who have rightfully inherited them.

But *muniments* has, in the course of ages, acquired a somewhat different sense; and from betokening the documents themselves, it is sometimes used to denote the *depositories* of these documents.

Still, by those who aim at speaking with precision, it denotes the written documents themselves. It is also rarely used in reference to any small collection of such documents, or when the interest to be *defended* is small. In such cases the correlative expressions are *title-deeds*, or *evidences*, which means however precisely the same thing, only on a smaller scale. But when we speak of the documents by which the rights of a person are defended in whom a large estate has centred, or who inherits an ancient title, or vast manorial or ecclesiastical privileges, then the word of greater dignity, *muniments*, is often used; and still more when the evidences are spoken of which show the rights of the crown of any kingdom to its possessions, or the right of crown or people as sustained by written documents.

Private collections of evidences rarely contain anything that is of earlier date than the reign of Edward I. The public muniments of the English nation are believed to excel those of any other nation, both in number, preservation, and the remoteness of the period at which series or classes begin. Yet there is little previous to the reign of Richard I. There is no series commencing before that reign, except that of the Pipe Rolls, the Great Roll of the Exchequer, in which were entered, year by year, the receipts of the crown, and many of its payments. This series begins in the second year of King Henry II., and from that remote period to the year 1835, when this mode of keeping the account ceased, there is scarcely a roll wanting in the whole series. For the time previous to the beginning of that reign, one roll, which belongs to the reign of Henry I., only exists of the series; and the only other record of great importance before the reign of Henry II. is that called 'Domesday Book,' a survey of nearly the whole of the kingdom, made by William the Conqueror, a book which is still sometimes appealed to in determining rights of the crown, or of a subject against the crown, or of one subject against another.

For the particular classes of public muniments, their depositories, preservation, and other information concerning them, see RECORDS, PUBLIC.

MUNTZ METAL. [BRASS.]

MURDER. In the earlier periods of English jurisprudence, murder, *murdrum*, was a term used to describe the secret destruction of life, witnessed and known by none besides the slayer and any accomplices that he might have; so that the hue and cry, which the law required to be made after malefactors, could not be raised.

Murdrum was also the name of an amercement or pecuniary penalty imposed, until the reign of Edward III., upon the county or district in which such a secret killing had taken place. One of the modes of escaping from this penalty was, a presentment of Englishry; in other words, a finding by the coroner's inquest, upon the statement of the relations of the deceased, that he was an Englishman; the sole object of the amercement having been the protection of Danes, and afterwards of the Normans, from assassination by the English. (Glanville; Reeves.)

By the grant of "murdra," which is commonly found in ancient charters of franchises, the right to receive these amercements within the particular districts, passed from the crown to the grantee. Amercements for non-presentment of Englishry were abolished in 1340, by 14 Edw. III., st. 1, c. 4.

As the law formerly stood, every destruction of human life, not effected in this secret manner, with whatever circumstances of malignity and cruelty it might be accomplished, was treated as simple homicide. The law appears to have been gradually altered by the judges, in order to reach atrocious criminals whose offences would not formerly have been punishable as murder. As the law now stands, murder is the destruction of human life, accompanied with an intention on the part of the perpetrator of the offence to kill or do great bodily harm, or wilfully to place human life in peril; or resulting from an attempt to commit some other felony; or occurring in the course of resistance offered to ministers or officers of justice, or others rightfully engaged in carrying the law into execution. All other cases of culpable homicide, in which death is produced involuntarily, but is occasioned by want of due caution; or where, though death is produced voluntarily, the crime is extenuated by circumstances; or where a minister or officer of justice is killed, but sufficient authority did not exist, or was not communicated to the party before the fatal blow was given; or where any other circumstances essential to the crime of murder are wanting—amount only to simple felonious homicide, or, as it is commonly called, without regard to the age or sex of the party killed, manslaughter.

The law recognises the right of taking away life in the necessary defence of person or property, and it admits, in some cases, previous provocation as an extenuation of the offence. On the other hand, it makes special provision for the protection of officers and ministers of justice, where the killing of such officer or minister, though culpable, does not under the circumstances amount to murder.

In the modern law of England the crime of murder is characterised by having been committed with malice aforethought, or, as it is sometimes called *prepense;* which term, though in its ordinary signification it imports premeditation, has been extended to cases not only where the offender acts from a motive of ill-will towards another, with an express intention to destroy or injure him, but also where, without the existence of express malice, it is considered necessary, on grounds of policy, to punish homicide with the highest degree of severity.

The term "malice aforethought" is therefore frequently applied to a state of things in which no malice is felt in the ordinary sense of the term, but is only malice in a legal sense, by construction of law.

If A shoots at B with intent to kill him, but by mere accident kills C, this is a killing from implied malice. If A, by throwing a heavy stone from the roof of a house into the street in which he knows that people are continually passing, kills B, a mere stranger, this also is a killing from implied malice.

Implied malice is however very loosely defined in the law of England, if it can be said to be defined at all. It is stated, that the existence of implied malice is a pure question of law, or a conclusion of law to be drawn from all the circumstances of the case; and it is in some cases made to depend upon a very abstruse technical doctrine. The existence or non-existence of a criminal intention, even where that intention has no reference to any personal injury, but happens to be accompanied with a killing which is altogether accidental, is made to constitute the distinction between the higher and lower species of culpable homicide; and in other cases the existence of such criminal intention brings even an accidental killing within the scope of manslaughter.

Mr. Justice Foster says, "When the law maketh use of the term 'malice aforethought,' as descriptive of the crime of murder, it is not to be understood in that narrow restrained sense to which the modern use of the term 'malice' is apt to lead one, a principle of malevolence to particulars; for the law, by the term 'malice' in this instance meaneth, that the fact hath been attended with such circumstances as are the ordinary symptoms of a wicked, depraved, and malignant spirit. The *malus animus*, which is to be collected from all circumstances, and of which the court, and not the jury, is to judge, is what bringeth the offender within the denomination of wilful malicious murder. And I believe most, if not all the cases which in our books are ranged under the head of implied malice, will, if carefully adverted to, be found to turn upon this single point—that the fact hath been attended with such circumstances as carry in them plain indications of a heart regardless of social duty and fatally bent upon mischief." ('Discourse on Homicide,' 256, 257.)

This vague and figurative description of that which is propounded as a legal definition appears to furnish us with no certain test of the crime of murder. It amounts to no more than this: that, to constitute the crime of murder, the act must have been attended with such circumstances as in the opinion of the court, and not of the jury, are "the ordinary symptoms of a wicked, depraved, and malignant spirit," of "a heart regardless of social duty, and fatally bent upon mischief." It is a description of that which is rather matter of fact than of law. The question in each particular case is, whether the party acted in wanton and wicked disregard of the probable consequences of an act tending to the destruction of human life; which is an inference to be deduced from the evidence; and in arriving at which no assistance can be derived from the application of mere technical rules. The presence of that evil disposition of the mind of the offender which makes the offence murder, is known only by evidence of an act or omission by which human life is wilfully or wantonly exposed to peril.

Every homicide is presumed to be malicious until the contrary be shown. But upon the investigation, circumstances may transpire which extenuate the offence, and reduce it from the crime of murder to that of manslaughter; or the act may appear to amount either to justifiable or excusable homicide. In cases of justifiable homicide, and, according to modern practice, in cases of excusable homicide, the party causing the death is discharged from responsibility.

To constitute legal homicide, the death must result from injury to the *person* (as contradistinguished from causes operating upon the *mind*) occasioned by some act done by, or some unlawful omission chargeable upon, the party to whom such homicide is imputed. The terms "wilful omission" apply to every case of noncompliance with a legal obligation which the party may be under, to supply food, clothing, or to furnish any other assistance, or to do any other act, for the support of life or for the prevention of injury to it. It is not homicide unless death take place within a year and a day after the injury; or, in other words, it is not considered homicide when the party injured survives a whole year, exclusive both of the day of the injury and of the day of the death; nor where the death is to be attributed to unskilful treatment, or other causes not resulting from or aggravated by the injury sustained.

The law of homicide applies to the killing of aliens, except alien enemies slain in the heat and in the exercise of war; to felons, except when executed according to law; and to persons outlawed, whether on civil or on criminal process. But a child *in venter sa mere* (in its mother's womb) is not a subject of homicide, unless, subsequently to the injury, it be born alive, and die, within a year and a day from its birth, from the injury received whilst yet unborn. [INFANTICIDE.]

Criminal homicide is one of three kinds, murder, manslaughter, and self-murder. [SUICIDE.]

I. Murder is committed by:—

1. Voluntary homicide, without circumstances of justification, excuse, or extenuation.
2. Involuntary homicide, resulting from the commission of a felony, or from an attempt to commit felony.
3. Homicide, whether voluntary or involuntary, committed in unlawfully resisting officers or ministers of the law, or other persons lawfully acting for the advancement or in the execution of the law.

II. Manslaughter consists in:—

1. Voluntary but extenuated homicide, committed in a state of provocation, arising from a sufficient cause.
2. Involuntary homicide, not excused as being occasioned by mere misadventure.

This second class may be subdivided into:—

1. Involuntary homicide, resulting from some act done, or from the wilful omission to do some act, with intent to occasion bodily harm.
2. Involuntary homicide, resulting from some wrongful act done to the person.
3. Involuntary homicide, in committing, or in attempting to commit, an offence attended with risk of injury to the person.
4. Involuntary homicide, resulting from some act done without due caution, or from the unlawful omission to do some act.

Homicide not criminal is:—

1. Justifiable, as done for the advancement or in the execution of the law; or
2. Excusable, as done for the defence of person or property; or because it has, without the fault of the party, become necessary for his preservation.

The offence is extenuated where the act, being done under the influence of excitement from sudden provocation, or of fear, or of alarm, which may, for the time, suspend or weaken the power of judgment and self-control, is attributable to transport of passion or defect of judgment so occasioned, without any deliberate intention to kill or do great bodily harm; regard still being had to the nature and extent of violence used by the party inflicting the injury which causes death, as compared with the cause of provocation. The offence is not extenuated where, the cause of provocation being but slight, a return is made so excessive and disproportionate, that the killing cannot be attributed to mere heat of blood arising from the provocation given.

Homicide is neither justified nor extenuated by reason of any consent given by the party killed, as in cases of duels.

Homicide is justifiable, where the act is done in a lawful manner, by an officer or other person lawfully authorised, in execution of the sentence of a court of competent jurisdiction.

Homicide is justifiable, where an officer of justice, or other person duly authorised to arrest, detain, or imprison for any felony or for any dangerous wound given, and using lawful means for the purpose, cannot, otherwise than by killing, overtake the party in case of flight, or prevent his escape from justice; provided the officer knew, or had reason to believe, that the party attempting to escape was aware that he was pursued for such felony or wound given.

Also, where any officer of justice, or other person lawfully executing in a lawful manner any civil or criminal process, or other authority for the advancement of the law, or interposing in a lawful manner for the prevention or suppression of any breach of the peace or other offence, is unlawfully and forcibly resisted, and using no more force than is necessary to overcome such resistance, happens to kill the party resisting; or being, by reason of the violence opposed to him, under reasonable fear of death if he proceed to execute his duty, and because he cannot otherwise both execute his duty and preserve his life, kills him who so resists—in either of these cases the homicide is justifiable.

Homicide is also justifiable, when necessary for preventing the perpetration of any felony attempted to be committed by violence or surprise against person, habitation, or property; and where one, in defence of movable property in his lawful possession, using no more force than is necessary for the defence of such property against wrong, happens to kill the assailant; or being, from the violence of the assailant, under a reasonable and *bonâ fide* apprehension that he cannot otherwise both defend his property and preserve his life, kills the assailant; also where one in lawful possession of house or land, after requesting another, who has no right to be there, to depart, is resisted, and using no more force than is necessary to remove such wrong-doer and retain his possession, happens to kill such wrong-doer; or being, from the violence with which such wrong-doer endeavours to deprive him of possession under reasonable and *bonâ fide* apprehension that he cannot otherwise both maintain possession and preserve his life, kills such wrong-doer.

Homicide is excusable, when a man is involuntarily placed in such a situation that he is under the necessity of killing another in order to save his own life; as where, in a shipwreck, A pushes B from a plank which can save one only.

Homicide is not criminal, when it occurs in the practice of any lawful sport or exercise with weapons not of a deadly nature, and without intent to do bodily harm, and where no unfair advantage is intended or taken. But it amounts to manslaughter where weapons are used, the use of which is attended with probable danger; or where, in friendly contest, without the use of such weapons, death results from any unfair advantage taken, either as regards the nature of the instrument, the mode of using it, the want of due warning given previously to violence used, or from any want of due caution. Tournaments, though a sport in which deadly weapons were used, yet, being considered a useful training to arms, were lawful if held with the consent of the king. In case of death, therefore, in the course of one of these exhibitions, the criminality of the act appears to have depended upon the royal licence for the holding of the tournament. [TOURNAMENT.]

The statute of 9 Geo. IV., c. 31, s. 3, enacts, that every person convicted of murder, or of being accessory before the fact to murder, shall suffer death; and that every accessory after the fact to murder, shall be liable, at the discretion of the court, to be transported for life, or to be imprisoned, with or without hard labour, for any term not exceeding four years. Penal servitude is now substituted for transportation. By an act passed in 1752 (25 Geo. II., cap. 37), the bodies of persons executed for murder were directed to be delivered to surgeons to be dissected, or to be hanged in chains. The 2 & 3 Wm. IV., c. 75, required that such persons should be hung in chains, or buried within the precincts of the prison. The 4 and 5 Wm. IV., c. 26, s. 1, took away the former part of the alternative, and the mode of burial is the only circumstance which distinguishes sentences upon a conviction for murder from those pronounced in other capital cases. Formerly the murder of a bishop, abbot, or prior, by a person owing him canonical obedience, of a master or mistress by a servant, or of a husband by his wife, was denominated petty treason, and punished with greater severity than other murders. The party was drawn to the place of execution; and if the offender was a woman, burning was, as in the case of high treason, substituted for hanging; but by the 9 Geo. IV., c. 31, s. 2, petty treason is to be treated as murder only.

The offence of manslaughter is now punishable with penal servitude for life, or for a term of years, or with imprisonment, with or without hard labour, not exceeding four years, or with fine. (Foster; East; *Fourth Report of Criminal-Law Commissioners.*)

MUREXAN. [URIC ACID.]

MUREXID. [URIC ACID.]

MUREXÖIN. [CAFFEINE.]

MURIATIC ACID. [CHLORINE; *Hydrochloric Acid.*]

MURRHINE VASES. [VASES.]

MUSCA (the Fly), a constellation so called by Lacaille, being the Apis of Bayer. It is situated immediately below Crux, and between the latter and the South Pole. The principal stars are as follows:—

Character.	No. in Catalogue of Lacaille.	No. in Catalogue of British Association.	Magnitude.
α	5213	4245	4
β	5267	4280	4
γ	5184	4224	4
δ	5349	4353	4

MUSCOVADO SUGAR. [SUGAR.]

MUSES (*Musæ*, in Latin; Μοῦσαι, in Greek), the name of certain sister goddesses in the Greek mythology, who were supposed to preside over the arts of poetry and music, and the sciences of history and astronomy. The original conception of the Muses must be sought for in that disposition of the human mind which prompts us to embody abstract ideas in a sensuous form. Such seems likewise to have been the origin of the Graces, Fates, Furies, and other mythological personages of that class. [GRACES.] In the instance of the Muses, the powers of memory, music, and song were personified into individual goddesses, who were supposed to inspire men with these gifts. At first the Muses were said to be only three: Mneme, that is, "memory;" Melete, or "meditation;" and Aoide, or "song"; and they resided of old on Mount Helicon in Bœotia. (Pausanias, ix. 29.) According to the poet Alcman, they were the daughters of Uranus and Gæa, or the earth. Cicero ('De Natur. Deorum,' iii. 21) mentions four, namely, Thelxinoe, "mind-soother;" Arche, or "beginning;" Aoide; and Melete; and he says that they were the offspring of the second Jupiter. He goes on to say that there were other Muses, nine in number, born of the third Jupiter (the son of Saturn) and of Mnemosyne; and also a third family of Muses, called Pierides by the poets, who were the daughters of the third Jupiter and Antiope, and were similar in their names and equal in number to the preceding. Hesiod, in his 'Theogony' (53), reckons nine muses, daughters of Zeus and Mnemosyne, and gives their names as follows:—Calliope, Clio, Melpomene, Thalia, Euterpe, Terpsichore, Erato, Polyhymnia, and Urania, and he says that Pieria in Macedonia was their first dwelling-place. These are the Muses generally alluded to by the poets. It appears that the worship of the Muses was introduced from Macedonia into Bœotia, Phocis, and other parts of Hellas. The story of the contest of the Muses with the nine daughters of Pierus, a Macedonian, who pretended to rival the Muses in singing, but were vanquished and changed into magpies (Ovidius, 'Metamorph.,' v.) may have been, as some critics have conjectured, an allegory originating in the national vanity of the Greeks, to show their superiority in the arts and sciences over their Macedonian neighbours. The Thracian bard Thamyris tried a like chance, with a like result; he had his eyes put out and was deprived of his lyre.

Homer mentions the Muses as the goddesses of song, who inhabited lofty Olympus, but he does not specify their number or names. In the second book of the Iliad he invokes them, "to whom all things are known," to assist his memory while he is enumerating the leaders of the Greek forces at Troy. The occupations of the Muses were singing, dancing, and attending the banquets of the Gods. They were the attendants of Apollo and also of Bacchus. The name Musa is supposed by some to be derived from a Greek verb which means "to discover," because the Muses were said to be acquainted with recondite mysteries and future events; but this etymology is mere trifling, and the origin of the name is unknown. They were represented as handsome and modest virgins, with an intellectual expression of countenance, and dressed in long tunics, with wreaths of laurel, ivy, or palm leaves on their heads, or occasionally feathers, in allusion to their victory over the Sirens. It was only in later ages that peculiar attributes were given to each of them by the artists, and a peculiar department of science was assigned to each by the poets. In several paintings of Herculaneum they are represented with their respective attributes, and with their respective names written under each. By comparing these with several rilievos, medals, and mosaics, their identity becomes confirmed. The following is a list of the Muses, with the allegorical meaning of their names, and the attributes commonly borne by them:—

Clio, from *cleio*, "to celebrate glorious deeds," is represented with a scroll in her hand, and also sometimes with a "scrinium" to keep MSS. in, by her side; and is commonly seated. She has been styled the Muse of History.

Calliope, "fine voice," is represented with tablets and a style; sometimes with a trumpet in her hand; in some instances, as at Herculaneum, with a scroll like Clio. She was the Epic Muse.

Melpomene, "the singer," wears a royal diadem round her head, and a wreath of vine leaves, with cothurni on her feet; she so stands as to exhibit her full size, and holds a mask in the left hand, and a club in the right. She was the Muse of Tragedy.

Thalia, "the joyous," the Muse of Comedy, is also crowned with vine leaves, has a crook in one hand and a grotesque mask in the other.

Euterpe, "the pleasing," carries a double flute. She presided over music and lyric poetry.

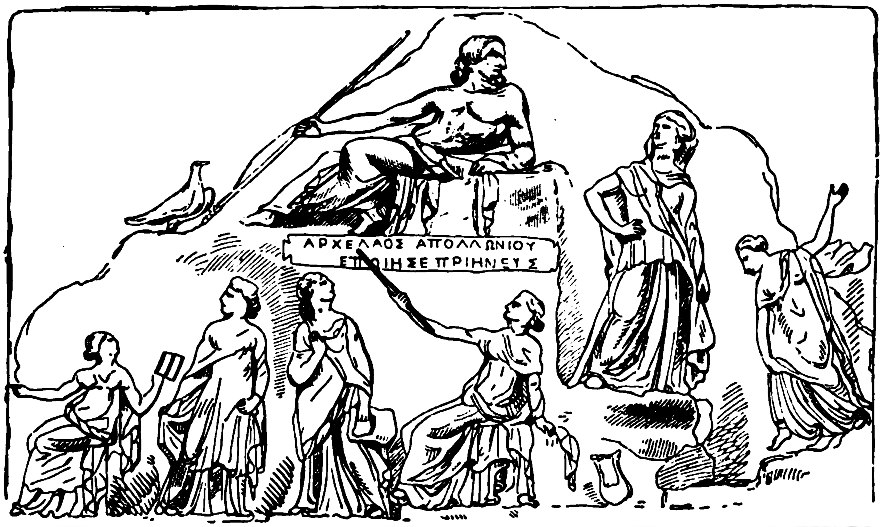
Terpsichore, "dance-loving," carried a lyre and plectrum, and presided over choral poetry and dance.

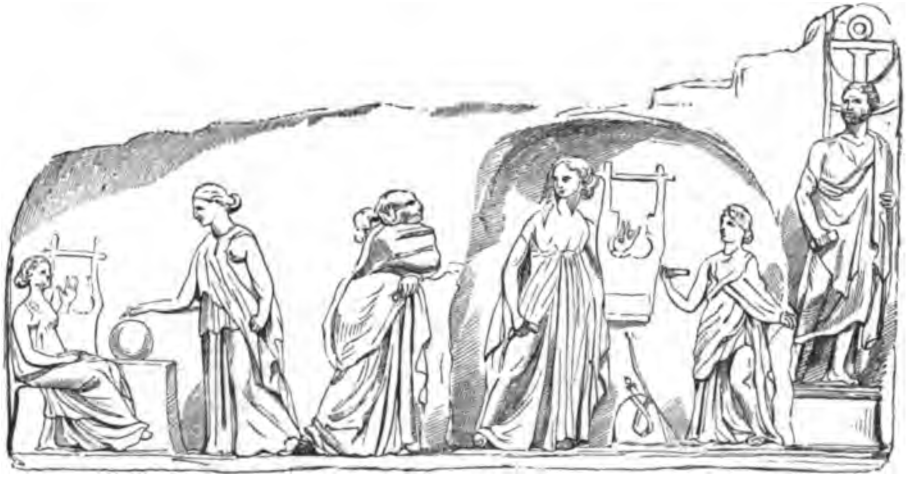
Erato, "the lovely," carries also a lyre. She was the Muse of elegy and amatory song.

Polymnia or Polyhymnia, "of many songs," is represented wrapped up in her cloak, and buried in meditation, usually leaning her elbow on a rock, sometimes with the fore-finger of her right hand across her mouth, in token of reserve and caution. She was the Muse of religious song, allegories, and mythical strains.

Urania, "the heavenly," has the globe and compasses in her hands, which are the emblems of her calling, astronomy.

In the Græco-Roman rooms in the British Museum, are several statues of different Muses; and the whole of them are twice represented in bassi-rilievi: on the front of a sarcophagus of later Roman date; and in the beautiful relief known as "Apotheosis of Homer," of the upper portions of which, containing the Muses, we give a cut. In this the Muses occur in the following order: commencing on the left of the upper line (below the figure of Zeus) we have—Calliope, with her tablets; Clio; Thalia; Euterpe, holding out the double flute; Melpomene, standing on a rock and addressing Zeus; next her, on the extreme right, is Erato (though some German archæologists take it to be Thalia, and that just noticed as Thalia to be Erato—the lyre is, however, the usual attribute of Erato); the first figure on the left in the lower row is Terpsichore; the next, Urania; the next, Polyhymnia. The figure more to the right is Apollo Musagetes, in female attire, within the Corycian cave, having a plectrum in his right hand, the lyre in his left, and at his feet the Delphic cortina, or tripod cover, bow, and quiver; the Pythian by his side is offering a libation in a patera.





[The Muses, from a basso-rilievo in the British Museum.]

The corruption which, in the course of ages, pervaded mythological symbols, did not spare the Muses, and accordingly we find their chastity denied by several writers. According to Apollodorus, Ovid, and others, Clio had Orpheus by Apollo, Euterpe had Rhœsus by the Strymon, Calliope was the mother of the Sirens by Achelous, &c.

The favourite haunts of the Muses were, Mount Parnassus in Phocis, Helicon in Bœotia, Pierius, Pindus, and Olympus, in Thessaly, &c. The swan, the nightingale, and the grasshopper were sacred to them. The Roman poets called the Muses Camenæ, an Etruscan name—for it appears that the Etruscans had also their Muses (Micali) and also Pierides.

A magnificent festival called *Museia* (Μούσεια) was held in honour of the Muses at Thespiæ in Bœotia, every fifty years.

(Creutzer, *Symbolik und Mythologie*; Petersen, *De Musarum Origine*, in Münter's *Miscellanea Hafniensia*; Hermannus, *De Musis fluvialibus*; Müller, *Handbuch der Archäologie*, § 393, and *Denkmäler der Alten Kunst*, &c., taf. lviii. lix., 732—750; Millin, *Galérie Mythologique*; Keightley's *Mythology of Ancient Greece and Italy*.)

MUSEUM, a place dedicated to the Muses, from the Greek *Mouseion* (Μουσεῖον); hence any place where learning is pursued, or which is set apart as a repository for things that have some immediate relation to the arts, is so termed. The earliest institution we are acquainted with which received this appellation was the museum founded about B.C. 280, at Alexandria by Ptolemy Philadelphus, for the encouragement of learning and the support of learned men. The buildings of this institution were afterwards enlarged by the emperor Claudius. (Suet., 'Claud.,' 42.)

MUSEUM OF PRACTICAL GEOLOGY. [SCIENCE AND ART, DEPARTMENT OF.]

MUSIC (*Musique*, Fr.; *Musica*, Lat.; Μουσική, Gr., from *μοῦσα* a *muse* or *song*) is the artistic union of inarticulate sounds and rhythm, exciting agreeable sensations, and raising mental images and emotions directly or indirectly pleasing. Such is pure unmixed music. When conjoined to poetry, it is an art not of diminished importance, but of a dependent nature, its office then being to enforce the meaning of the words and add a colouring to them. As an adjunct it is a beautiful illustration of language; combined with the sister art, it becomes a highly ornamented kind of eloquence.

Music is a kind of language, and as such, says Metastasio, it possesses that advantage over poetry which a universal language has over a particular one; for this last speaks only to its own age and country; the other speaks to all ages and countries. Music is a language that speaks by imitating, and as such it is understood by those who have successfully studied the art, and likewise by mere amateurs, who, with little if any knowledge of its principles, have learnt the meaning of its expressions by long practice, by frequently hearing and enjoying its performance; but it can only express passion and sentiment very generally, and commonly fails when it attempts to particularise. This want of absolute decision in what is called musical language is by some writers reckoned among its advantages, because it gives the hearer great latitude in interpreting it, which he usually does in a manner as congenial as possible to his own feelings at the time.

A musical sound—which is a curious compound of other sounds, called harmonics, resulting from a number of vibrations in equal times —when produced by a fine voice, a rich-toned violoncello, or a "mellow horn," excites in all who possess a moderate share of nervous sensibility a pleasurable sensation; and this, Sir John Herschel observes, "is perhaps the only instance of a sensation for whose pleasing impression a distinct and intelligible reason can be assigned."

Dr. Beattie does not think it absurd to suppose that the body may be mechanically affected by sound. "If," he says, "in a church one feels the floor and the pew tremble, to certain tones of the organ; if one string vibrates of its own accord when another is sounded near it, of equal length, tension, and thickness; if a person speaks loud in the neighbourhood of a harpsichord, and often hears the strings of the instrument murmur in the same tone, we need not wonder that some of the finer fibres of the human frame should be put in a tremulous motion when they happen to be in unison with any notes proceeding from external objects."

The surprising connection between form and vibrations producing musical sounds, so beautifully shown in Chladni's experiments on plates of glass strewed with sand, and put into sonorous vibration, thereby throwing the sand into various symmetrical figures, may be here incidentally mentioned. Though it does not seem to shed any new light on the subject before us, nevertheless, by proving something like sympathy, and of a much more extraordinary kind than that between two strings, in mere matter, it may at a future period lead to interesting discoveries.

The effect of rhythm, or measure, is universally felt and admitted: the most polished inhabitants of Europe, and the most barbarous natives of the arctic regions, are alive to its influence; it is that which reduces unmeaning sounds to order, converts them into melody, and bestows on them proportion and a power to charm. The chirping, or whistling, or singing, as it is called, of most birds, being devoid of rhythm, affords no pleasure but what is derived from association; while the single note of a drum, beaten in time, combining sound and measure, is gratifying in a certain degree to every hearer. Indeed, with the ancients rhythm was of paramount importance, if not almost everything, in what they denominated music, a term under which was included much that it does not imply in modern language. Aristides Quintilianus, the best of the seven Greek writers on music collected by Meibomius, remarks that rhythm is the object of three senses, namely, the sight, as in dancing; the hearing, as in music; and the touch, as in the pulsations of the arteries.

Much of the effect of music on the mind is ascribed to imitation, which is either direct or indirect. And it must be understood that we are still speaking of music strictly instrumental, not vocal. The power of direct imitation is confined within narrow limits, though composers have often attempted to enlarge the boundaries at the risk of exposing their own weakness and that of their art. The song of some birds, the whistling of winds, the roaring of the tempest, the sound of cannon, the ringing and tolling of bells, and the tones of the human voice expressive of certain emotions, are considered as legitimate objects of direct imitation; but it has been affirmed that the rattling of hail, the fall of snow, the motions of animals, actions at sea, battles on land, &c., are not only unrepresentable by any kind of musical instrument at present known, but unfit for imitation if instruments could be constructed for the express purpose. Of all the powers of music, in the opinion of a good critic, the Rev. Thos. Twining, that of the raising of ideas by direct resemblance is the weakest and least important. "It is indeed so far from being essential to the pleasure of the art, that unless used with great caution, judgment, and delicacy, it will destroy the pleasure by becoming offensive or ridiculous. The highest power of music, and that from which it derives its greatest efficacy, is undoubtedly its power of raising emotions."

Indirect Imitation is that by which some quality common to music and the thing imitated is indicated by sounds, strong or weak, quick or slow. Rage is loud, anger is harsh, love and pity are gentle; therefore loud and harsh sounds raise ideas of the former passions and others of the same class; soft and tranquil sounds raise ideas of the latter and others of a similar character. Hence it will be seen, as before observed, that the hearer may interpret music in a manner corresponding in some degree to the state of mind in which it shall find him, but under certain restrictions from which he cannot be released. If agitated by any turbulent passion, he will find it impossible to convert smooth and delicate music into a language in unison with his irritated feelings; and if under the softening influence of some tender attachment, or of sorrow for the loss of one beloved or valued, he will be unable to construe bold and brilliant sounds as expressions of sympathy. But music that is not of a decided character will prove more or less convertible.

Association, which has so large a share in the operations of the human mind, often contributes much to the effect of music. Indeed some airs, possessing no intrinsic merit, owe their influence solely to this principle, and among these the famous *Rans des Vaches*, which, in times happily gone by, acted with such irresistible force on the expatriated Swiss soldier. It was many years after the battle of Culloden, and not till all fears of the Pretender had subsided, that the Scotch bagpipers ventured to play any of the Jacobite tunes, which, when revived, were heard with delight, though hardly one of them would have continued to be listened to but as connected with the history of the country.

After all, however, that has been written and said, from the days of Aristotle down to the present period, of music as an imitative art, it must be conceded that modulated sounds please, by some mysterious means, many to whom they present no imitation of anything, material or immaterial, and who associate with them no other idea than that of melody or of harmony.

Thus far our attention has been directed to instrumental music, that which is dependent on no auxiliary for effect, on no words to explain its meaning, on no gesticulation or scenery to illustrate it. We have now to consider music as produced by the human voice in alliance with language, whether poetical or prose, and with or without instrumental accompaniment.

Vocal music is entirely devoid of that ambiguity which some think a merit in instrumental music, and some consider a defect. Words fix the intention of musical sounds, leaving nothing for the hearer to conjecture; for though the more or less of truth in the expression will depend on the skill of the composer, yet he must be utterly destitute of reason to give to revenge the tones of love, or to joy those of despair. It is true that he does not always read with discriminating judgment the words selected by him, or committed to his charge; that in emphasis he is sometimes erroneous, and in accentuation frequently faulty; and for these failings in the artist, the art itself has been unjustly condemned by writers whose repute gives weight to their censure. But the heaviest charge brought against composers of vocal music, and that which has exposed them to the keenest ridicule, is the eagerness to express the literal meaning of a particular word rather than the sentiment, the sense of the entire passage. This exceedingly vulgar kind of imitation, which has not inaptly been called *musical punning*, may be traced to a gross misapprehension of the rule, that "the sound should seem an echo to the sense," and is the vice not only of composers of an inferior order, but occasionally of some of the highest class. The great Handel himself is not wholly exempt from its influence. In the fine chorus, "Wretched lovers, quit your dream" (in 'Acis and Galatea'), when the line "Hark! how the thund'ring giant roars" occurs, he makes the bases roar in a long division, till they nearly gasp for breath. But this is a verb that proves very seductive to composers: in two of our best glees it sets the voice a-roaring through several bars:—in the one, because the poet (Ossian) asks, "Who comes so dark from ocean's *roar?*" In the other, because the poet (Gray) sings "The rocks and nodding groves re-bellow to the *roar!*" Handel's favourite air, "What passion cannot music raise and quell!" from Dryden's 'Ode to St. Cecilia's Day,' sends the voice tumbling down a full octave at the words "faces fell." In the same work the singer is condemned to ascend to a note which few can reach, and none can sustain without lungs of very unusual capacity, merely because the author says, "The trumpet shall be raised on *high*." Our greatest English composer, Purcell, could not resist the temptation offered by the words "They that go *down* to the sea in ships," from the 107th Psalm, in setting which he commits the bass voice to so very low a deep, that there was only one man in his day who could sing the anthem. "Some eminent musicians," Sir William Jones observes, "have been absurd enough to think of imitating laughter and other noises; but if they had succeeded, they would not have made amends for their want of taste in attempting it; for such ridiculous imitations must necessarily destroy the spirit and dignity of the finest poems." This discerning and elegant writer most likely points at the song and chorus, "Haste thee, nymph," in Handel's setting of Milton's 'L'Allegro,' in which is the line, "And Laughter holding both his sides." The singers in this, it must be allowed, never baulk the intention of the composer, but affect to laugh almost convulsively. Many other instances of similar mistaken efforts at direct imitation might be adduced from the works of Handel, and that great composer's supremacy in the art renders him especially liable to animadversion when misled by an erroneous conception of the words; but he has been charged with many supposed imitations which he never contemplated, such as the *whipping-chorus*, the *rocking-chorus*, &c. We have however said as much as is necessary on this part of our subject.

In the accompaniment to vocal music, much greater freedom of imitation is allowable than in the voice part: kept within the bounds which good sense and cultivated taste prescribe, it affords very efficient aid, by giving greater force to the poetry, and contributing to the completion of the general design. It also adds harmony to some, a most important, if not an indispensable support. Nearly all that imitation can do, should—as the elder Dr. Gregory, of Edinburgh, in some admirable remarks on music, has observed—be assigned to the accompaniments, as these, on account of the greater compass and variety of instruments, are better adapted to such a purpose than the voice, which ought to be left at liberty to express the sentiments. If Handel has sometimes failed in imitations by the voice, he has often succeeded in those by the accompanying instruments. We need but refer in proof to his beautiful song in 'Il Penseroso'—

> "Oft on a plot of rising ground
> I hear the far-off curfew sound,"—

where he has imitated the bell by the deep-toned strings of the bass, confining the voice to those notes of pleasing, contemplative melancholy, the idea of which the words so completely excite. The same skill and discrimination are shown in the song of Galatea, "Hush! ye pretty warbling quire," in which the flute imitates the birds, leaving the singer to express in simple sounds that languishing tenderness ndicated by the poetry. Handel was the first who endeavoured to xcite the idea of light through the agency of musical sounds: his horus in the oratorio of 'Samson,' "O first created beam!" was written with this design; and moreover suggested to Haydn that grand comosition on the same subject which is admitted to be one of his noblest riumphs. But the still bolder attempt of the former great master was to convey to the mind, through the same medium, a notion of darkness. With this view he composed the sublime chorus in 'Israel n Egypt,' beginning, "He sent a thick darkness over all the land," the ccompaniments to which, assisted by the words, produce on persons usceptible of musical impressions all that solemnity of effect, not unmixed with awe, intended by the author. The same may be said of he remaining plagues, in which the instrumental is the imitative and uggestive portion of the music, while the vocal portion is frequently but a simple plaintive air. The accompaniment to the words "There came all manner of flies," is wonderfully expressive of myriads of litting, buzzing, fluttering, humming insects in motion; and the description of the entrance of the frogs even into the king's chamber, s rendered vivid by the measured leap performed by hundreds of nstruments, and that without the slightest approach to the ludicrous. That grand chorus which announces the congealing of the waters, is mainly indebted for the extraordinary sensations which it produces to the marvellous accompaniments, which seem to betoken a solidifying stiffening process, gradually extending over the whole orchestra and over the listeners. Some of the grandeur of these effects is due to the greatly increased orchestras of the present day, which go far to realise the composer's original idea. A full orchestra in former days contained perhaps 100 performers, whereas at the present time 1500 skilled musicians may take part in these choruses.

Haydn, though sometimes ambitious of achieving by musical means more than the art can accomplish, was often most happy in indirect imitation by instrumental accompaniments; witness the magnificent burst of sound in the first chorus—to which we have just alluded—in The Creation,' at the words, "and there was light." Witness also his musical picture, in the same oratorio, of the rising sun, the slow swell of the instruments in ascending notes describing the gradual progress of the luminary towards the horizon, and the full power of the band depicting its refulgent splendour. And how beautifully the composer contrasts with the solar blaze, the soft, serene beams of the comparatively small orb which reflects its borrowed light!

Music, which is both a science and an art, is divided into *Speculative* or theoretical, and *Practical*. Speculative Music explains the nature of musical sounds; shows, by demonstrating their ratios, how they are related to each other; and investigates their physical and moral effects when in a simple or in a combined state: it is, in few words, the philosophy of the art. Practical Music is the application of theoretical principles,—the proper conduct of sounds as to their progression, duration, union, and adaptation to words, voices, and instrument, and is the art of composition. The performer, who merely executes, stands in the same relation to music as the actor does to the drama, or the reciter to the poem: though he requires, in order to excel, considerable knowledge of the subject and superior taste, yet he is but an operator—a singer or a player, and not, strictly speaking, a musician.

Speculative Music is subdivided into Acoustical, Mathematical, and Metaphysical. [ACOUSTICS; HARMONICS; SOUND; TEMPERAMENT.] Practical Music into Vocal and Instrumental, the several kinds of which are noticed under their respective heads. The chief component parts of practical music are, MELODY, HARMONY, and RHYTHM, to which we refer. See likewise ACCENT, AIR, CHORD, COMPOSITION, COUNTERPOINT, MODULATION, THOROUGH-BASE, TIME, &c.

MUSIC, HISTORY OF. The origin of music is involved in an obscurity which no ingenuity, no labour, has hitherto been able to dispel; analogy and conjecture, therefore, have supplied the want of facts, in the absence of any assistance except what doubtful histories and the fables of mythologists have afforded, which at best have held out but a dim light, and more often misled than aided the inquirer in his researches.

It has been supposed by some writers whose names stamp a value on all that has proceeded from them, that song and speech are coeval, an opinion which will hardly be disputed, if by song are meant sounds which, though vocal and sustained, are devoid of rhythm, governed by no scale, and consequently productive of no melody, in the modern acceptation of the word; but if the term is intended to signify a regular system of tunable measured notes, then we shall not hesitate to say that such advance towards art could only have been made by people proceeding fast in civilisation, and communing through the medium of a language adequate to all the ordinary purposes of man in a social state.

We are told by Lucretius, in a passage often quoted from the fifth book of his poem 'De Rerum Natura,' that the birds taught man to sing, and that the invention of musical instruments of the inflatile kind was suggested to him by the sounds produced from reeds when the western wind blew over them:—

> ———————— "the birds instructed man,
> And taught him songs before his art began.
> And while soft evening gales blew o'er the plains,
> And shook the sounding reeds, they taught the swains;
> And thus the pipe was fram'd, and tuneful reed."

This has certainly the merit of being very poetical, whatever reliance the historian may place on it. The same notion concerning wind instruments is found in Ovid's beautiful account of the transformation of the nymph Syrinx into reeds. But Thomas Aquinas, the "Angelic doctor," cited by Padre Giambattista Martini, in his 'Storia della Musica,' disdains to follow the example of the heathen author of the 'Metamorphoses,' or the disciple of Epicurus, and leave the origin of music to chance; on the contrary, the noble Italian saint informs us that the first man was endowed by the Creator with every kind of knowledge, and that he excelled in music, as well as in all other arts and sciences.

But quitting the ingenious guesses and fictions of poets and the reveries of enthusiasts, we find Jubal, the seventh in descent from Adam, mentioned in Scripture as "the father of such as handle the *harp* and *organ*." These terms, however, must not be understood quite literally; they are generic, and signify all instruments of the stringed and tube kind. The different versions vary in the translation of the original: the French render the word *harp* by *violon*. Though the earliest authentic record of music extant is that in Genesis, yet it is nearly certain that the Jews acquired their knowledge of it from the Egyptians. The whole generation of the Iraelites led forth by Moses from their captivity were born in Egypt, in which it seems to be agreed music as an art originated; though Diodorus Siculus even denies that it was ever practised there: but his assertion is not only in opposition to Herodotus, and at utter variance with what Plato says, who travelled into that country to become acquainted with the arts and sciences, but is proved by modern discoveries to be the very reverse of truth. The fresco painting of a harp, found by Bruce in an ancient tomb near the ruins of Thebes, which is undoubtedly of very high antiquity, is an indisputable proof of the progress made by the early Egyptians in music. In form, dimensions, and ornament, this instrument might be mistaken for one of modern date, insomuch that when a drawing of it was first shown in London considerable doubts were entertained of its fidelity. Forty years after, however, M. Denon bore testimony to the truth of Bruce's description and the accuracy of his sketch, since which Rosellini's 'Monumenti dell' Egitto' and Wilkinson's 'Ancient Egypt' have confirmed all that the two former had said on the subject. Other instruments have been found sculptured or painted on Egyptian monuments, several of which are in the British Museum, and they furnish evidence of the state of music in Egypt in the remotest times. These are sufficient proofs of early Egyptian knowledge in the musical art. That it continued to be cultivated in Egypt under the Macedonian dynasty there can be no doubt. Athenæus, in his account of a Bacchic festival given by Ptolemy Philadelphus,—the munificent patron of all the liberal and useful arts, who made Egypt the mart of the world,—tells us that more than 600 musicians were employed in the chorus, and that among these were 300 performers on the cithara, or lyre.

Of the music of the Hebrews, nearly all that is known is to be collected from the Scriptures, and the Bible is in the possession of every one. There we meet with the first recorded song, which Moses sang at the head of the tribes, after the miraculous passage of the Red Sea. To this responded Miriam the prophetess, having a timbrel or tambourine in her hand, and being attended by all the women, carrying the same instruments, and dancing. Music formed an essential part of every Jewish ceremony. The priesthood were musicians by office, which was hereditary: they were 4000 in number, divided into bodies, each of which had its chief or leader. At the dedication of Solomon's temple a prodigious band of priests, blowing trumpets, attended. Josephus tells us that 200,000 musicians were engaged; but as his statement is unsupported by scriptural history, we may venture to consider it as a mistake arising from some misapprehension, or else as a manuscript error. A Hebrew writer enumerates 36 musical instruments that were kept in the sanctuary, all of which, he says, the prophet-king David could play. These are reduced to 33 by another account. It is worthy of remark that many of them, under other names, are still met with in the East and in Egypt, and, as far as can be ascertained, very little changed from their original form. Martini has given, from a manuscript of 1599, what he believes to be specimens of the melodies sung by the Jews to certain Psalms; but they are printed in the obsolete notation, without bars, and having no words added to them by which the measure might perhaps have been made out, it is impossible to enter thoroughly into their meaning.

The music of the Greeks has engaged the notice of so many searching antiquaries and patient mathematicans—such profound learning and unwearied labour have been bestowed on it—it has provoked so much controversy, and the dispute has proved so barren, that we enter on the subject reluctantly, if not fearfully. But before proceeding further, we think it right to say that, after a diligent investigation of the subject, on which we entered with an unprejudiced mind, it is our decided opinion that what is now called Greek music has hitherto proved perplexing chiefly, if not solely, on account of the term having been misunderstood. We believe that by *mousike* (μουσική) the Greeks meant *poetry sung*, with some sort of accompaniment, and that the moderns have fallen into error by overrating the importance of the melodic part, treating this as the principal, and poetry only as an ally.

Music was a comprehensive term with the Greeks, embracing, among other things which we shall have occasion to mention, melody (*melopœia*, literally the *making*, or composition, *of the song*) and poetry. There is no one, M. Villoteau remarks, who, after an attentive perusal of the ancient writers, is not convinced that eloquence, poetry, and melody were in early times governed by musical principles, that they were taught by the same master, and that the three arts were but one science. The Greeks never separated poetry from melody; the poet himself set the notes to his own verses, and in the early times sang them at the public games and festivals. The Greek tragedies were *operas*, observes Payne Knight, meaning, we presume, that they were in a kind of recitative; and he is borne out in his assertion by the best authorities. Aristotle, in his treatise on poetry, considers the *music* of tragedy as one of its most essential parts. The nature of this *music* is indicated by several writers, but is more clearly pointed out by Philodemus than by any other, in his work in abuse of music (one of the *papyri* found in Herculaneum, unrolled and published at Naples in 1793), wherein it is described as a melody nearly approaching ordinary speech; that is to say, recitative. Horace calls Apollo *the singer*. The ancient poets give us to understand that their verses were *sung*, and this is to be construed literally in the case of the Greek poets. Homer, according to tradition, sang his own epics. But it is needless to multiply proofs of a fact so generally received.

Admitting, then, that Greek poetry of all kinds—religious, epic, dramatic, &c.—was really sung, let us imagine what was meant by the word *singing*. It is not to be imagined that Homer, Tyrtæus, Pindar, &c., were singers, in our acceptation of the word; the supposition is too absurd to be entertained for a moment. But even allowing them to have been as perfect in the vocal art as the moderns are, would they have condescended to deliver their poetry in long flights of notes, in divisions, in trills, and in passages that render it difficult, and sometimes impossible, to get at the sense? If, however, they had attempted to make their "heaven-bred poesy" subservient to song, would they have found a patient audience?—Assuredly not; for the animating appeal, the interesting narrative clothed in poetical language, the pathetic description, were what the Greeks delighted in, and certainly would not have surrendered for the sake of a tune. Moreover, it must be recollected, and is a very important consideration, that when the art of printing was unknown, and manuscript copies of poems, &c., were unattainable by the people at large, on account of the expense, the multitude had no means of becoming acquainted with the productions of their poets but by hearing them recited; and as crowds assembled for this purpose, the best mode of rendering the voice of the reciter audible to many, and these congregated in open places, was, to pitch it rather high, and confine it to a small number of fixed musical notes. Such is still the practice, and with the same intent, in all cathedrals, and is called chanting—a usage which has doubtless been transmitted from the remotest ages. Such, too, is the method adopted by the *improvvisatori*, whose art, we are persuaded, is of the highest antiquity, and whose singing, it is our belief, much resembles that of the ancient Greeks in delivering their verses. Those extemporaneous poets always require an instrumental accompaniment of a simple kind, to keep the voice in tune, and, as they confess, to animate them. The Greek reciters also were accompanied either by the lyre or the flute, and probably for the same purposes. The flute was the companion of elegiac poetry; the lyre of the epic and the ode.

By what is called Greek music, therefore, we understand the union of poetry and music, the former of the two exercising the greatest sway over the mind, because expressing noble sentiments, gracefully inculcating religion and morality, teaching obedience to the laws, exciting generous feelings, and inspiring patriotism and courage by the praise of those who had distinguished themselves by their public services and their valour. It is thus we account for the effects said to have been wrought by ancient music; for it is impossible that Plato should have been thinking of mere vocal melody and the sounds of mean and imperfect instruments, when he said that no change can be made in music without affecting the constitution of the state—an opinion in which Aristotle acquiesced, and which Cicero afterwards adopted. It is not to be credited that the laws of Lycurgus, set to measured sounds by Terpander, were turned into a song, or that this Lesbian musician quelled a sedition in Sparta by singing some pretty air to the mob. It is absurd to suppose that when Polybius tells us of a savage nation civilised by music, he means to say, by coarse pipes and guitars;—and not less ridiculous is it to imagine that men were raised to the rank of chiefs and the dignity of legislators, solely on account of their taste in singing, or their skill on the lyre and the flute.

We cannot quit the subject of the vocal music of Greece without adding a few words concerning the Greek *Nomes* and *Scolia*. The former (from *νόμος*, nomos, *a law*) were so called, says Plutarch, because they were not allowed to transgress certain melodic rules by which they were characterised, and were at first hymns to the Gods. The latter were songs of a less restrained kind, sung at banquets and entertainments, by great proficients; hence Hesychius derives the term from *σκολιὸς* (skolios, *difficult to sing*). But others think that the word should be rendered literally,—*crooked, following a tortuous course*,—because, at table, it did not pass regularly, but only to those who were skilful singers. Plutarch, on the authority of Pindar, tells us that the *scolia* were invented by Terpander. Müller, in his 'History of the Literature of Ancient Greece,' considers Terpander to "have been properly the founder of Greek music." He also invented the seven-stringed lyre, and was probably the first to set poetry to music.

As to the instrumental music of the Greeks, we confess our inability to treat the subject in a satisfactory manner. The accounts given us by the ancient writers are either so suspicious or so indefinite, that nearly all our labour in endeavouring to gain some knowledge of its nature has been expended in vain. Having Bianchini's learned work on ancient instruments before us, we are enabled to form some opinion of their capabilities, and our opinion is not in their favour. They appear to have been rude, and suited only to music of the simplest description.

The musical scale, or disdiapason, of the Greeks comprised two octaves, the lowest note of which was A, the first space in the bass of the moderns. This was divided into five Tetrachords, or subdivisions of four sounds in each, the extremes being at the distance of a fourth. [TETRACHORD.] The notes or sounds were represented by the letters of the alphabet, great and small, which, in order to extend their application and distinguish the various modes, were placed in different positions—the direct, the averted, the inverted, and the horizontal; and these were, as occasion required, altered in form. The time or duration of the notes was known by the long and short syllables to which they were set; the long syllable was in duration as two, the short as one. But we know only the comparative times of these; of the positive lengths of notes we remain in ignorance. The movement however of Greek music is supposed to have been slow. The modes were, according to Alypius, fifteen in number: Aristoxenus makes them thirteen, each a semitone distant from the next in order. Under the word MODE we have given the table of Alypius; that of Aristoxenus, the oldest of the Greek writers on music, commences with the Hypodorian, the lowest, and varies considerably in the key-note from that of Alypius, and there are no certain means of reconciling the discrepancy.

By the word *μέλος* (*melos*) the Greeks generally signified what we call air, or something like it; but sometimes, Twining remarks, "they used it in the sense of *ἁρμονία*, that is, *melody* abstracted from rhythm, or time; sometimes for *measured melody;* and sometimes as equivalent to *song*, including melody, rhythm, and words." By ἁρμονία (*harmonia*) they intended simply to express, as we have in a former article observed, the proper relationship of one sound to another—a pleasing agreement of intervals; that is to say, melody. Metastasio believes that by this term the Greeks signified what we mean by melody, founding his opinion on the following passage from Plato ('De Legib.', lib. ii.):—*The regulation of the movement is called* rhythm; *but the regulation of the voice is called* harmony.

The long-contested question, whether the Greeks understood counterpoint, or music in parts, seems now to be set at rest, and determined in the negative by a preponderating weight of authority and a large majority of voices. To what we have before remarked on this subject [HARMONY], we now add, that further inquiry and reflection have only confirmed the opinion we have long entertained, namely, that though the ancients, by mere accident, if not from experiment, must have been acquainted with the effect of simultaneous sounds, nevertheless that which we call harmony formed no part of their musical art, either theoretically or practically. And we repeat our belief, that in the union of poetry and song, which undeniably operated with such amazing force on all classes of the people,—which inflamed them with ardour,—softened them into obedience, and melted them into pity,—music was but the ally of verse.

Of their instrumental music, or music without the voice, we are told that the flute-players by profession—who certainly were exceedingly encouraged and most extravagantly paid for their services in the later times of Greece—piqued themselves chiefly on the strength of the sounds they could produce from the instrument; and that the trumpeters thought themselves fortunate if, in their contests at the public games, they escaped without the rupture of a blood-vessel by the violence of their exertions. It is to such performances Aristotle must allude in saying, "I disapprove all kinds of difficulties in the use of instruments, and, indeed, in music generally; I mean such tricks as are practised at the public games, where the musician, instead of recollecting what is the true object of his art, endeavours only to flatter the corrupt taste of the multitude." Facts and remarks like these do not lead to any favourable opinion of Grecian performers. It is likely however that they pleased most when they played the airs set to the favourite poems and popular verses. And there seems some reason to believe that they extended these by additions, sometimes studied, but often extemporaneous, resembling what are in modern language called variations, or an amplification of the theme.

It was a tradition that Cadmus, with his Phœnicians, introduced music into Greece. But Plutarch, in his 'Dialogue on Music,' first makes Lycias, a professor of the art, repeat the statement of Heraclides, that Amphion, the son of Jupiter and Antiope, taught the Greeks to compose and sing lyric poetry: then, by a second interlocutor, Soterichus, contradicts the first, assigning to Apollo the merit of having converted Greece into a musical nation. The invention of the lyre of three strings is given to the Egyptian Mercury, or Thoth; that of seven strings, to the second or Grecian Mercury. Chiron, the centaur, taught Achilles music. Orpheus was the musical pupil of Linus, and master of Hercules. Then came Olympus, Terpander, and others. Terpander is said to have appeased an insurrection in Lacedæmon by his songs. He rendered a most important service to the art by inventing a method of representing musical sounds. The his time music was quite traditional, and depended on the memory, and sometimes the caprice, of the performer. Plutarch says of him, on the authority of Alexander, an historian, that he took Homer for his model in versification, and Orpheus for the style of his melodies. The musical compositions of Orpheus, the same writer adds, were wholly original.

Many very celebrated players on the flute are mentioned in musical history. Damon taught Pericles and Socrates the use of this instrument. Antigenides and Dorion were also renowned for their talents. But the performer who excited most admiration was of the gentler sex. Lamia was no less distinguished by wit and ability than by personal charms. After captivating many by her skill as a flute-player, and by her beauty, Demetrius Poliorcetes became violently enamoured of her, and, through her influence, conferred such extraordinary benefits on the Athenians, that they dedicated a temple to her. Whatever may have been the style of flute-playing, or of the music, it is certain that in Greece the performers were in great favour. Xenophon says, that if an indifferent player wished to pass for one of superior talent, he must furnish his house richly, and appear abroad with a large retinue of servants, as the great performers do. It is said that a flute used by a celebrated Theban musician, Ismenias, cost nearly six hundred pounds sterling.

Pythagoras, of whom an idle story was long current, about a blacksmith's shop, hammers, and anvils, contributed much to the improvement of music by his calculations and philosophical experiments. To him also is attributed the addition of an eighth string to the lyre. His notion concerning *the music of the spheres*—music produced by the motions of the heavenly bodies—was one of those whims in which great geniuses are apt, now and then, to indulge. He was of the sect of severe musicians, of those who reduced music to mathematical precision, and regulated all sounds by calculations, allowing no licence to the ear. Of an opposing school was Aristoxenus, born at Tarentum in Italy, about 350 years B.C., who thought the ear entitled to share with mathematical principles in determining the effect of modulated sounds. He was a most voluminous writer on many learned subjects. Of these his 'Elements of Harmonics' are all that have reached us, and stand first in the collection published by Meibomius. Next in that excellent work is an 'Introduction to Harmonics,' by Euclid, the geometrician; and this is followed by his 'Section of the Canon,' containing short and clear explanations of the constituent parts of Greek music. Ptolemy, an Egyptian, and not the astronomer, wrote a treatise in three books on 'Harmonics,' which Dr. Wallis printed, with a Latin version, a preface, and appendix, in 1682. He enters at large and deeply into the subject, and his principles have a tendency to reconcile the hostile sects of Pythagoreans and Aristoxenians. This object was pursued with success, by Sir F. H. Styles, in his paper published in the 51st volume of the 'Philosophical Transactions.' In Plutarch's 'Dialogue on Music' much information concerning ancient Greek music is to be found, but not of the most valuable kind. Aristides Quintilianus wrote a treatise on music, printed in the collection of Meibomius, which has proved a useful work to all subsequent writers on the subject. He was enthusiastic and fanciful, but in matters of fact and calculation is worthy of confidence.

The Romans acquired all their knowledge of the arts and sciences from the Greeks; their music therefore in no way differs from that of the latter; though they must have had some kind of song before any direct intercourse had taken place between them and the polished nations of Greece. It is certain that the art was never advanced by that warlike people, notwithstanding the share it had in all their religious ceremonies and public games, and the use made of it to animate their troops and add effect to their triumphs, and though it formed an essential part of their theatrical exhibitions of every kind, and was even adopted, or affected to be adopted, as a profession by one of their emperors.

The importance of music in the estimation of the early Romans is shown by a regulation attributed to Servius Tullius, who, in dividing the people into classes, directed that two whole centuries should consist of *trumpeters, blowers of the horn*, &c., and such as, *without any other instrument, sounded the charge.* It is further proved by a law of the Twelve Tables, which limited the number of *players on the flute* at funerals to ten. And another of those laws enacted, that at the praises of honoured men in the assemblies of the people, there should be mournful songs accompanied by a flute.

That the Roman drama was in some way musical, is proved by the title, or *didascalia*, prefixed to each of Terence's plays. A further proof of this is found in the Institutes of Quintilian, where, after showing the necessity of instructing children in music, he adds, "that he does not desire that they should learn such music as prevails on the stage, the modulations of which are so intermixed with impudence and wantonness, that they may justly be charged with having extinguished the poor remains of manly courage which had been left." That the theatrical music of the Romans was similar to that of the Greeks there seems to be little doubt; that it was distorted by the performers in Quintilian's time is very likely.

It is remarked by Dr. Burney, that even during the Augustan age the Romans had no sculptor, painter, or musician, and but one architect, Vitruvius; those, he says, "who have been celebrated in the arts at Rome having been Asiatics or European Greeks, who came to exercise such arts among the Latins as the Latins had not among themselves. This custom was continued under the successors of Augustus; and those Romans who were prevented from going into Greece contrived in a manner to bring Greece to Rome, by receiving into their service the most able professors of Greece and Asia in all the arts."

The Roman writers on music are few, and almost worthless. Vitruvius, in his work on architecture, treats of the sound of the voice, of reverberating vases, and of a *water-organ;* but no one has yet been able to discover what he means by this instrument. He also endeavours to make plain the harmonical system of Aristoxenus, though he acknowledges the difficulty of the task. St. Augustine wrote on rhythm and metre; Boethius devotes five books to music, merely to explain the principles of harmonics; and Aurelius Cassiodorus treats of music, among other things, but his work, or sketch, is said to consist of little more than some general definitions and divisions.

There is every reason to conclude that music remained stationary till the 10th or 11th century. The Romans, having borrowed the art from Greece, seem to have been convinced of its perfection in the state in which they received it, for there is no evidence of their having attempted to enlarge its narrow boundaries, or in any way to improve it; though a people of more ingenuity and taste would have advanced it at least a few steps towards that point which, however slowly, it has now attained.

In the primitive Christian church the service consisted partly of music, which is supposed to have been chiefly that of the Greeks, with an admixture of Hebrew melody. Menestrier conjectures that the early ecclesiastical manner of singing was like that of the ancient theatre, and Dr. Burney concurs in this opinion; though we cannot but think it more likely that the "songs of Zion," as performed in the Jewish temple, and the chanting of the hymns at the Pagan altars, were chosen as vocal models for devotional purposes, rather than the airs, or recitatives, in which the comedies of Plautus and Terence were delivered. Towards the end of the 4th century, St. Ambrose digested a musical service for the church of Milan, which is called the Ambrosian chant, and was founded on four of the Greek modes. About the year 600 Gregory the Great enlarged and much improved the chant of the church, by the admission of four other modes, and gave it that form which it still retains in the Roman Catholic service, and in which it is known by his name. According to Bishop Stillingfleet, music was introduced into the English church by St. Augustine, in the latter part of the 6th century, and was subsequently much improved by St. Dunstan, an excellent musician, who, it is said, furnished some few churches with an organ.

The organ—the most majestic and comprehensive of all musical instruments in its present almost perfect state—is supposed to have been an improvement of the hydraulicon, or water-organ, of the Greeks. The first mentioned in musical history was sent, in 757, as a present to King Pepin, from the Byzantine Emperor Constantine Copronymus. In the 10th century the organ was in use in several parts of Europe; but it is reasonable to conclude that it was then exceedingly simple, possessing little power, and rude in mechanism: nevertheless, it may fairly be assumed that the invention of the organ hastened the discovery or practice of harmony. [ORGAN.]

To Guido, of Arezzo, we are indebted for many of those improvements in music which led to our present system; though the origin of counterpoint has been erroneously ascribed to that active and ingenious ecclesiastic. [GUIDO, in BIOG. DIV.] Magister Franco, a member of the cathedral of Cologne in the 11th century, is considered as the inventor of what in the middle ages was called *Cantus Mensurabilis*, which meant, notes showing, by their forms, their time or duration. Most of these, however, have fallen into disuse, for the shortest in his table is the semibreve. Nevertheless his system, carried out further by De Muris, and by degrees extended, is that of the present day, and is so sound in principle that it probably will never be abandoned.

From the 11th to the 15th century, scarcely anything is known of the progress of music. For its history from the latter period, we refer to the biographical sketches of its most eminent professors which appear in the Biographical Division of our work;—to the articles ACADEMY, CONCERT, OPERA, ORATORIO, &c.;—to the names of musical instruments; and to all the terms under which musical compositions of every kind are described. From these sources may be gathered much of the information, if not all, that will be required by the general reader.

MUSK, *Medical Properties of.* Musk, taken in the dose of a few grains, rouses the energy of the digestive organs; and it soon afterwards produces sympathetic phenomena the powers of the whole animal system appearing suddenly increased. By repeating the dose till half a drachm or a drachm is consumed, the active principles penetrate the whole frame, influencing all the tissues, and exciting effects demonstrative of its stimulating property; the blood circulates with more force, accompanied sometimes with bleeding from the nose: the perspiration and other secretions are perceptibly increased. Other effects prove that it also acts on the brain, spinal chord, and ganglionic nerves, such as tendency to sleep, convulsive movements, and particularly spasms of the chest and abdomen. Owing to idiosyncracies, musk produces in some persons very extraordinary effects, at times so violent that they cannot bear the faintest odour of it.

there exist low delirium, hiccup, twitching of the tendons, &c. But its beneficial action is not so constant as to justify much reliance upon it. It is much more useful in diseases purely nervous and spasmodic, where no inflammatory action has preceded or is present. Hence even in epilepsy, as well as hysteria, it is serviceable. In laryngismus stridulus, called epileptic croup, or crowing respiration, of children, it is very useful. In combination with ammonia it is useful in arresting a tendency to gangrene. Likewise in retrocedent gout it has proved successful. It was found of little avail in severe cases of Asiatic cholera, though useful in the milder forms of it.

Artificial musk should never be used for medical purposes.

MUSKET. [ARMS.]

MUSLIN, a thin cloth, or fine calico, made of cotton. The name is supposed to be derived from Masalia, since called Masulipatam, near Madras, from which place such fabrics were first imported into Europe. Until the early part of the present century all the muslin used in Europe was the manufacture of India. The durability of the India muslins is not, as some have supposed, the consequence of any superiority in the quality of the material of which they are made; for the raw cotton of India is far inferior to that which is used for these fine fabrics in Europe, and which is brought from America and from Egypt. The excellence of India muslins is owing to the skilfulness and patience of the spinners and weavers in that country. Some of the muslins of India, and especially those of Dacca, are of the most astonishing degree of fineness, so as to justify their poetical description as "webs of woven wind." Such however has been the result of the inventions of England in this branch of industry, that not only are the muslins of British manufacture now used at home, almost to the exclusion of those woven in India, but large quantities are exported to all parts of the world, and find their way even far into the interior of India. Some of the kinds now made by machinery are of exquisite fineness. [COTTON MANUFACTURE.]

Paisley and Manchester are the chief seats of the muslin manufacture. Glasgow houses now carry on a vast trade in worked or embroidered muslin. At first, the women and girls in the district within twenty miles of that city were employed in the work; but afterwards it was found that an abundant supply of such labour could be obtained in the north of Ireland. Even so early as the beginning of the present century, it was estimated that 20,000 females earned a living at this muslin work. When working, the muslin is stretched over a hoop, and kept in its place by means of another hoop slightly larger in diameter; the hoops are either held between the chin and the knee, or supported on some kind of stand. The embroidering is a kind of chain stitch, produced by the needle. There are, however, other kinds of sewed muslin work for which no hoop or tambour is required. The extension of the trade to Ireland was chiefly determined by the circumstance that, when machine flax-spinning was introduced in that country, the hand-spinners were thrown out of employment, and were glad to accept the work which the Glasgow firms offered to them. Until about the year 1830 the patterns for the muslin-workers were printed from engraved blocks, which in some cases cost as much as five guineas each; but the lithographic press has greatly increased the rapidity and lessened the cost of producing patterns; and, as one among many favourable consequences, the artistic merit of the designs has been much increased. Agents for the wholesale houses visit the country districts, seek out and employ the women and girls, supply them with the muslin, fetch it away when finished, and pay them for their work. In busy times, agents for two or three firms will compete with each other at the same place; and the usual result, a rise in wages, is produced. The earnings begin at 6*d*. per week for young workers, and rise to 6*s*.; first-class hands occasionally earn 10*s*. All the women and girls work at their own homes, the employment being essentially a domestic and not a factory one. It was estimated, so far back as 1851, that not less than 600,000*l*. was thus paid annually to women and girls for muslin-working, chiefly in the west of Scotland and the north of Ireland.

A somewhat analogous, but still distinct, application of female labour is noticed under EMBROIDERY AND SEWING-MACHINES.

MUSTARD, OIL OF. White mustard-seed yields about 36 per cent. of a yellow fixed oil, which appears to consist of glycerin united with two acids,—erucic acid ($C_{44}H_{42}O_4$) and oleic acid. In addition to this fixed oil, mustard yields when moistened an essential oil [FERMENT] which is the sulphocyanide of allyl (C_6H_5S, CyS). This body may be obtained in a state of purity by rectifying the essential oil of mustard, and also by distilling together sulphocyanide of potassium and iodide of allyl.

Sulphocyanide of allyl is a colourless oil possessing an acrid taste, and the excessively penetrating and pungent odour which is so well known in mustard paste. It is only slightly soluble in water, but soluble in all proportions in alcohol and ether. It has a powerful blistering effect when applied to the skin.

Sulphocyanide of allyl rapidly absorbs ammonia, producing *thiosinamin*.

$$\underbrace{C_8H_5NS_2}_{\text{Sulphocyanide of allyl.}} + NH_3 = \underbrace{C_8H_8N_2S_2}_{\text{Thiosinamine.}}$$

urea.

$$\underbrace{2C_8H_5NS_2}_{\text{Sulphocyanide of allyl.}} + 6PbO + 2HO = \underbrace{C_{14}H_{12}N_2O_4}_{\text{Sinapoline.}} + 2(CO_2, PbO) + 4PbS$$

MUTINY ACT is an annual measure passed by parliament to confer on the executive government the right to raise and maintain in this country for the ensuing year a standing army, consisting of a specified number of men, and subject to the laws and discipline of war comprised in the act itself, and in the articles of war issued annually under authority of the statute by her Majesty.

Laws have, at various times, been made by the authority of the crown for the maintenance of discipline in the army when in garrison, on a march, and in the presence of an enemy; these have been briefly hinted at in the article on MARTIAL and MILITARY LAW, and may be seen at length in Grose's 'History of the English Army' (vol. ii.); but the code which is now in use is one of the first-fruits of the Revolution in 1688. Previously to that event the crown, except during the civil wars and the subsequent protectorate, had, at least practically, the supreme power over the militia (that is, over the whole military force), which, with or without the consent of the nation, might be called out and employed as long as pay and quarters could be obtained for the troops. But the efforts then recently made to carry out a series of measures tending to the maintenance and extension of arbitrary power in the crown, joined to the increasing jealousy of the people for their civil and religious liberties, led the two houses of parliament to take the earliest opportunity, after the new king had been called to the throne, of expressing in some public act of legislation their authority over the regular troops of the nation; and an opportunity almost immediately presented itself, on occasion of a serious mutiny taking place in the army. While the Royal Scotch and Dumbarton regiments, under Marshal Schomberg, in their progress to the coast for the purpose of being embarked for Holland, were quartered at Ipswich, a large body of men refusing to proceed to their destination, disarmed their officers, seized the military chest, and, with four pieces of cannon, began their march for Scotland. Being pursued by General Ginckel, with three regiments of Dutch dragoons, they surrendered at discretion; but, in consequence of this event, and on the spur of the moment, a bill was passed (April 12th, 1689) by which the army was put at once under the control of the law with respect to discipline, and under its protection with respect to pay and quarters.

The enactments of this measure were particularly directed against the crimes of mutiny and desertion, for which the bill was immediately required; but the Act itself begins by laying down as maxims that the raising or keeping a standing army in the country in time of peace, unless it be with the consent of parliament, is against law; and that no man can be forejudged of life or limb, or subject to any kind of punishment in any other manner than according to the established laws of the realm. It then states that it is judged necessary, by their Majesties and the parliament, during the present time of danger and for the defence of the Protestant religion, to continue and augment the forces which are now on foot. Avoiding the acknowledgment that any power exists in the crown for the appointment of courts-martial, it authorises their Majesties to grant commissions to general officers to assemble such courts for the purpose of trying and punishing such offences as mutiny and desertion. Provisions are also made that nothing in the Act shall exempt an officer or soldier from the ordinary processes of law; that it shall not concern the militia troops, and that it shall only continue in force till the 10th of November in the same year. The Act has ever since, with one exception, been annually renewed: after the bill which passed in April, 1697, for one year as usual, had expired, no other was passed till March, 1702; and, on a few occasions, the bill has been suffered to expire for several days before the following one received the royal assent.

The Mutiny Act has, with time, varied in many particulars from that which was first passed, but it has been uniform in all its principal points; such as the dependence of a standing army on the consent of parliament, and the subjection of military men to all the processes of ordinary law. Instead however of the original formula above-mentioned, by which the reason of keeping up a military force was expressed, the Act now asserts that it is judged necessary by the crown and parliament to continue a body of forces (the number being exactly specified) for the safety of the United Kingdom, the defence of the possessions of her Majesty's crown, and the preservation of the balance of power in Europe. In all the Acts which passed down to the commencement of Queen Anne's reign the articles were few in number, and some of them were very ill defined; but, from that time, parliament seems to have intended to exercise a general legislative jurisdiction over the army. Many new articles were then inserted; others have since been added, as the want became apparent; and the Mutiny Act may now be considered as a good general code of law, in which are defined strictly but briefly all military offences of the higher class, and, as precisely as possible, nearly all those of minor importance. The military offences of the higher order, comprised in eleven classes, consist in any commissioned or non-commissioned officer, or soldier, exciting mutiny, or in not using his best endeavours to suppress

, or not giving information thereof without delay to his commanding fficer; in misbehaving before an enemy; shamefully abandoning or elivering to the enemy any garrison, fortress or post; compelling the overnor of such garrison to do so; using means to induce any one to misbehave before the enemy, or shamefully to abandon or deliver up ny garrison fortress, or post committed to his charge; quitting his post without leave, or sleeping at his post; holding correspondence with, r giving advice or intelligence to the enemy; or entering into terms with any enemy or rebel without licence; using or offering violence to superior officer, or disobeying his lawful commands; or offering iolence, whilst confined in a military prison, to any visitor or superior fficer in the execution of his duty; and, finally, in deserting the ervice. For all these offences the Act prescribes "death, or such ther punishment as a general court-martial shall award;" provided lways that two-thirds of the court do concur in any judgment of death. The Act then enumerates the military offences of minor mportance, and the punishments which may be assigned in respect of ach. Embezzlement, fraudulent misapplication, wilful damage, theft or connivance at the same, of money, provisions, forage, arms, clothing, ammunition, or other stores, by any paymaster, commissioned officer, or other person employed in the war department or concerned with the care or distribution of such property, makes the offender liable to not ess than four years' penal servitude, or to fine, imprisonment, dismissal from the service, reduction of warrant or non-commissioned officer to the ranks, with incapacity to serve her Majesty, as a general court-martial shall think fit, in addition to his liability to make good the loss. It is in the power of any court-martial to award corporal punishment, not exceeding fifty lashes, for disgraceful conduct, misbehaviour, or neglect of duty;—of any general, district, or garrison court-martial to award in addition imprisonment with or without hard abour, or solitary confinement;—of any general court-martial in addition to award forfeiture of additional pay, good conduct pay, pension on discharge, annuity or medal for past or future services;—and such additional forfeiture may be awarded by any district or garrison court-martial for desertion or for disgraceful conduct by the offender in wilfully maiming himself; tampering with his eyes; wilfully by any act producing or aggravating disease or delaying his cure; malingering, or feigning disease; stealing government stores; stealing from any officer or comrade, regimental mess or band, or feloniously receiving the products of such offence; making or procuring false accounts; embezzling public money; committing any other offence of a felonious or fraudulent nature, or for any disgraceful conduct being of a cruel, indecent, or unnatural kind. He is also liable to forfeit his pay when absent from duty improperly, or in consequence of his offences, and to be subjected to stoppage of pay to make good bounties fraudulently obtained or loss or damage inflicted by his offence. There is also power to dismiss a soldier from the service with ignominy, or mark a deserter with the letter D in ink or powder indelibly, and the terms of imprisonment which may be awarded by the different courts-martial are specifically ascertained.

Besides the above laws, which relate particularly to the discipline of the army, the Act defines the constitution and powers of courts-martial [Courts-martial]; it contains provisions relating to the enlistment of recruits [Discipline; Enlistment], the issue of pay and marching money, the quartering of soldiers, and the supplying of carriages for the conveyance of troops and baggage. The Act moreover contains a repetition of the original clause in which it is declared that the ordinary course of law is not to be interfered with when a soldier is accused of any felony or misdemeanor or any crime or offence, other than the misdemeanor of refusing to comply with an order of justices for the payment of money, provided that no soldier be taken out of the service for a debt under 30*l*. or for breach of contract, except by desertion as an apprentice from his master when bound to him for seven years.

The Mutiny Act is declared to be applicable to all persons employed in the recruiting-service; to the forces of the Indian army while in any part of the United Kingdom, and till their arrival in India; to the officers and men employed in the service of the artillery and engineers; to the corps of the sappers and miners; to the military surveyors and draughtsmen in the ordnance department; to foreign troops serving in any part of the British dominions abroad; and to all storekeepers and all civil officers of or under the war department at home or abroad. Its provisions also extend to the islands of Guernsey, Jersey, Alderney, Sark, and Man; but not to any of the militia forces, or yeomanry, or volunteer corps of Great Britain or Ireland. It applies also to officers holding rank by brevet, though not to such as are on half-pay. An effort was made in 1749, when the bill was introduced as usual into parliament, to subject officers of this latter class to martial law, but the clause was abandoned by the minister. Before the union of Ireland with Great Britain there was a separate Mutiny Act for the former country, but now the same Act applies to both. The officers and troops of the Indian army are subject to their own Mutiny Act, which however agrees generally with that of the forces of the British army.

Previously to the year 1750 the members of courts-martial were bound by an oath not to disclose the ground on which they gave their votes; but in that year the Act was so far mitigated as to release them from such oath when required to give evidence in any court of justice or court-martial. The power of disclosing, in that case only, the votes or opinions given is implied in the forms of the oaths which are now taken by the judge-advocate and members of the court-martial, and which are printed among the schedules to which the Act refers. The Act of the same year also contains a clause, in which it is stated that no sentence pronounced by a court-martial, and signed by the president, shall be more than once revised; previously to that time a general-officer had power to order the revisal of any sentence as often as he pleased, and thus he might retain in confinement a man who had been acquitted on a fair trial.

The gradual extension of the provisions of the Mutiny Act to those military offences which may be considered as secondary in the scale, does not seem to have been noticed on behalf of the crown further than by the occasional reservation of its right to make Articles of War for the better government of the forces, which is expressed in the acts passed during the reign of Queen Anne. In the first year of George I. this right of the crown was formally allowed; and the clause containing it has been repeated in all subsequent Mutiny Acts, with the provision that no person within the United Kingdom and British Isles shall be subject to penal servitude, or to any punishment affecting life or limb, for crimes specified in the Articles of War, except such as by the Mutiny Act itself are liable to the same punishments.

The Articles of War which are at present in force, and which have from time to time been promulgated, are divided into five sections comprising together 160 articles. Many of these correspond exactly to clauses in the Mutiny Act; others, though relating to subjects in the latter, define the particulars of the crime and the punishment applicable to it with more precision; and there are articles which have no counterparts in the act. The first section relates to the duties and obligations of officers and men, including the forms of enlistment; the second to crimes and punishments, being necessarily much more specific and detailed than the statute, the object of the latter being generally to confer powers and ascertain the limits of their exercise; the third to courts-martial; the fourth to rank among officers; and the fifth to the persons who are subject to the Articles of War.

The above articles, being made by the crown as head of the army, are to be obeyed as being the commands of a superior officer; but in the opinion of writers on military law, the legality of the articles may itself become the subject of examination in a court-martial; whereas the Mutiny Act must be obeyed without inquiry.

The Marine Mutiny Act, closely resembling that which has already been described, is also a statute passed annually, and is applicable to the marines when they are on shore.

The Act on which are founded the Articles of War for the Navy was passed in the 22nd Geo. II., and this consolidated all the laws previously made for the government of the ships and vessels bearing royal commissions, as also of the forces at sea. Among the offences which in the Act constitute the crime of mutiny, are, the running away with the ship, or with any ordnance, ammunition, or stores belonging to the same; neglect of duty; joining in or using means to produce any mutinous assemblage of persons; uttering mutinous or seditious words, or concealing any mutinous intention; and striking an officer or disobeying his lawful commands. Of the thirty-six articles, nine relate to crimes for which the punishment of death, without discretion in the court-martial, is awarded; and there are twelve to which are assigned "death, or such other punishment as the nature and degree of the crime shall be found to deserve." Two of these were originally in the former class, and the qualifying clause was added in the 19th Geo. III. Except this alteration, none has been made in the Navy Act since it was passed.

MUZARAB, that is, a Christian living under the sway of the Arabs. Various etymologies have been assigned to this word, but the real derivation of the word *Muzarab* is the Arabic *Mustarab*, afterwards corrupted into *Muçarab*, which means a man who tries to imitate the Arabs, or to become one in his manners, language, and habits; and who, although knowing Arabic, speaks it like a foreigner. This name was given by the Moors of Spain to all Christians living under Moslem jurisdiction in Cordova, Seville, Granada, Toledo, and other large cities.

But the word Muzarab is better known to us as connected with the ancient liturgy of the Goths, which governed the Spanish church down to the 12th century, and was called "Muzarabic office" ('Missal Muzárabe'), owing to its being preserved by the Muzarab Christians of Toledo during the time of their subjection to the Arabs. The fate of the Muzarabic liturgy is singular enough. Though involving the same doctrines, it differed widely from the other offices of the church; it also contained many hymns composed by St. Eugenius, St. Ildefonso, St. Julian, St. Leander, and other great luminaries of the Visigoths. To produce uniformity in this respect, and substitute the Roman for the Spanish missal, became the principal aim of the holy see. Early in the 10th century a legate arrived in the Peninsula from Rome, sent by John X.; but the report which he made on his return proved to be a favourable one, and by the decision of a council, held at Rome in 924, the Muzarabic office was not only sanctioned, but even praised. Another attempt, made in 1064, under Alexander II., had a similar result. Again, in 1067, new legates were sent, with a positive injunction to insist on the abolition of the ancient service; but the Spanish prelates resisting the innovation, the subject was laid before a council assembled at Mantua, and the Spanish missal was once more declared Catholic and orthodox. Still the holy see persisted in its object. No artifice or intrigue was spared; and the court of Castille was divided into two hostile factions, one in favour of and the other against the introduction of the Roman ritual. In the perplexity occasioned by this dispute the two parties resolved to leave the decision to the judgment of God, and the expedient adopted to discover the divine will was this: two wild bulls were procured, the one to represent the Roman, the other the Muzarabic ritual, and, in the presence of the king and the court, were matched against each other. After a bloody conflict, the *Muzarabic* remained victor. But this result did not deter Gregory VII. In 1087 the trial was repeated: a champion was chosen on each side, and the decision left to the fate of arms; but again victory was in favour of the ancient liturgy. Fire was then tried, and both missals were cast into the flames; but, if we believe the archbishop Don Rodrigo, who was present at the ceremony, the success was still more signal; for no sooner did the Roman volume touch the fire, than it jumped out of the flames half burnt, while the Spanish remained for a considerable time in the midst of them without receiving the least injury. The object was at last gained by other means. Alfonso, the renowned conqueror of Toledo, was won over to the interests of Rome, and, after much trouble and difficulty, he prevailed on the prelates of the kingdom to receive the universal office; and from that moment the Muzarabic, although not publicly condemned, fell into disuse. There is however still a chapel in the cathedral of Toledo where mass is performed every day agreeably to the Muzarabic ritual. It was founded by Cardinal Ximenes de Cisneros.

(Masdeu, *Historia Critica*, lib. ii.; Mariana, *Historia General de España*, lib. ix., chap. xviii.; *Missale Gothicum secundum Regulam Beati Isidori Hispalensis*, Romæ, 1804.)

MYCOMELIC ACID. *Mycomelinic Acid.* [Uric Acid.]

MYELITIS. Inflammation of the substance of the spinal cord. The spinal cord is liable to the same inflammatory affections as the brain. [Meningitis.] It is covered like the brain with membranes, which may be diseased independent of the substance of the cord, which like the soft part of the brain may also be diseased independent of its membranes. Inflammation of the cord and its membranes is a frequent accompaniment of a similar disease on the brain.

The membranes of the cord may be inflamed separately or together. The dura mater of the cord may be inflamed on its free or its adherent surface. This is sometimes the case in caries of the vertebræ. This inflammation may be attended with effusion or ulceration. The spinal *arachnoid* and *pia mater* may also be inflamed, and the same results observed as in the same membranes in the brain. These membranes are red and injected to a considerable extent, and serum or lymph are effused according to the severity of the inflammation.

The symptoms of inflammation of the different membranes cannot be well made out. The one great characteristic of all these inflammations is intense pain. This pain extends along the spine, and passes to the limbs, and is not unfrequently mistaken for rheumatic pain. With the pain there is a tendency to the disturbance of the muscular action. There may be rigidity or tetanic contraction of the muscles of the back, amounting in some cases to perfect opisthotonos. The muscles of the lower extremities may be affected in the same way. There may be also retention of urine, priapism, and obstinate constipation. In the commencement of the disease neither the pulse nor the tongue are much affected, but as the disease advances the pulse becomes rapid and the tongue brown, as the patient falls into a low typhoid condition.

The treatment in these cases should consist of opiates to alleviate the patient's sufferings, and of local bleeding, and purging with neutral salts. The hot bath in the acute stage, with setons, moxas, and leeches in the chronic stage should be employed. Mercury is not recommended.

Inflammation of the substance of the cord occurs independent of any affection of its membranes. This may also occur idiopathically, or as the result of accident. The symptoms of inflammation of the cord are very varied, according to the part of its structure which is affected. Tracing the inflammation from above downwards, all or any of the following symptoms may be observed. Convulsions of the muscles of the head and face, difficulty of articulating, or an entire loss of voice, spasm of the muscles of the jaw, difficulty in swallowing, irregular or spasmodic breathing, palpitation or intermittent action of the heart, constriction of the chest, dyspnœa, nausea, and vomiting, pains in the bowels, sense of a cord tied round the belly, difficulty in making water, retention of urine, incontinence of urine, constipation, involuntary evacuations, convulsions of the voluntary muscles, and palsy.

If the seat of the disease is above the origin of the phrenic nerves, or the third cervical vertebræ, death speedily takes place, as the nervous influence is no longer transmitted to the diaphragm, and other muscles of respiration. When the injury is below the origin of the phrenic nerves, or at the level of the fifth and sixth cervical vertebræ, the inspiration is free, but the expiration is laborious from paralysis of the intercostal and abdominal muscles. The patient can yawn, but cannot sneeze. The upper extremities are also usually paralysed in this case. If the inflammatory affection is a little lower down, as opposite the seventh cervical, the palsy of the upper extremities is incomplete, but that of the trunk and lower extremities is o When the lesion occurs opposite the first or second dorsal ver the upper extremities may not be at all paralysed, but the lower will be perfectly so, and the respiratory muscles are still affected when the lesion is in the part opposite the lumbar vertebræ, the lower extremities and the bladder are affected.

From these general remarks, it will be seen that the sympto inflammatory affections of the cord can only be understood by refe to the physiology of the spinal cord. [Nervous System, in N Hist. Div.]

Inflammatory affections of the spinal cord, when independ accident, are usually fatal; nevertheless, recoveries are suff numerous to justify the medical man in the persevering judicious remedies. Cases often occur in which the active dis arrested, but in which the paralytic affections remain.

In the treatment of this disease, care must be taken not antiphlogistic remedies too far. Bleeding is not recommended paralysis has taken place. At first, purgatives may be had recours but as the case becomes chronic, tonics, and even stimulants, borne and found necessary. Counter-irritation over the region affected part of the spine should be produced by blisters, &c care must be taken that there is no tendency to gangrene, likely to set in in these cases. One great point to be attended these cases is, the state of the bladder. Although urine may be pa voluntarily or involuntarily, the bladder may nevertheless, fro paralysed condition, remain in a distended state, and if the wa not drawn off by the catheter bad consequences will result. I of great importance to keep the patient clean and dry, as if this attended to ulceration will occur in the parts with which the in contact, and increase the suffering and danger of the patient.

(Watson, *Lectures on the Principles and Practice of Physic*; *The Science and Practice of Medicine.*)

MYRIAD (μυρὰς), the Greek term for ten thousand; employed in our idiom for an indefinite but very large number.

MYRICIN. [Bees' Wax.]

MYRICYL. [Bees' Wax.]

MYRICYLIC ALCOHOL. [Bees' Wax.]

MYRISTIC ACID ($C_{28}H_{27}O_3 + HO$), is a crystalline fatty acid in the seeds of *Myristica moschata*, the common nutmeg. Com with glycerin, it forms the fat of the nutmeg; with the oxide of a myristic ether which is an oily liquid.

Myristic acid has also been recently found amongst the produ the saponification of spermaceti.

MYRISTICA MOSCHATA. Nutmeg. [Myristica, in N Hist. Div.] The genuine nutmeg must not be confounded with Californian nutmeg, the produce of the *Torreya myristica*, a native of middle Florida, growing on calcareous hills along the side of the river Appalach, and at Aspalaga.

This is so called not from its spicy qualities, nor from possessin of the intrinsic properties of the nutmeg, but from its cone bear very close resemblance to that fruit, more especially in the rumin appearance of its seed. See 'Bot. Mag.' pl. 4780; also 'Edinb New Philos. Journ.,' vol. x., July 1859, p. 7.

MYRISTONE ($C_{26}H_{27}$, $C_{28}H_{27}O_2$?) The ketone of myristic It bears the same relation to myristic acid as acetone does to acid.

MYRONIC ACID. An acid of unknown composition con along with *myrosin* in black mustard. In contact with myrosin water it gives essential oil of mustard, or sulphocyanide of [Ferment.]

MYROSIN. [Myronic Acid.]

MYROSPERIUM. Balsam of Peru, according to Richter, con two oils, *myroxylin*, which is insoluble in alcohol, and *myrosper* which is soluble in that liquid. The latter substance when tre with an alcoholic solution of potash, yields cinnamic acid and a resi body.

MYROSPERMUM. Balsam of Peru and of Tolu. All conje respecting the sources of these balsams are set at rest. They are only the produce of trees specifically distinct, but of trees growin very different countries, that yielding balsam of Peru bein produce of a new species of myrospermum, described by the late Royle under the name of M. Pereirae. It somewhat resemble *M. pubescens*, of Kunth. It grows only on the *Balsam Coast*, which the neighbourhood of Sonsonate, State of St. Salvador, Guatem reaching from the front of Acajutla, to that of Libertad. Th seems that none comes from Peru, though the name would imply it does. Royle's 'Materia Med.', 3rd edition, 1856.

Balsam of Tolu flows from incisions in the tree, and is of the sistence of a strong turpentine. It is sent to Europe in earthen jars or tin cases. It becomes tenacious with age, and in cold wea may be fractured, but melts again in summer, or with the warmth the hand. It is of a yellow or brownish colour, transparent, with taste and odour of the white balsam of Peru. This balsam is adulterated. All the three forms possess the ordinary qualities balsamic substances, and, either in the state of syrup or tincture, employed where such medicines are indicated. These have already detailed [Balsams], and it is only necessary to state here their fragrance renders them pleasant adjuncts to cough mixtu hen the acute or active stage is passed, while the difference of price the only reason for preferring one kind to another.

MYROXOCARPIN ($C_{48}H_{33}O_{6}$). A resinous body extracted from e white Balsam of Tolu.

MYROXYLIC ACID. *Carbobenzoic Acid.* An acid obtained from alsam of Peru. It is probably impure benzoic acid.

MYRRH, *Medical Uses of.* [BALSAMODENDRON, in NAT. HIST. DIV.]

MYSTERIES. [DRAMA; *French Drama.*]

MYSTERY (*μυστήριον*). In the religion of the Greeks there were tes and doctrines which were kept secret from the mass of the eople and only communicated to a chosen few. These things were alled *mysteries.* This word has been adopted by the writers of the ew Testament, who apply it to things which are kept secret for a ime and afterwards revealed, or to things which are kept secret from ome persons though they may be revealed to others, or lastly, to hings, which, though not kept perfectly secret, are only made known y symbols. Thus the term answers pretty well to the English word *ecret.* It is frequently opposed to words which imply *discovery.* Thus he New Testament writers speak of a *mystery revealed* (*μυστήριον ποκαλυφθέν*) or *brought to light* (*φωτωθέν*) or *made known* (*γνωρισθέν*). hey call the gospel a mystery, as being a system which had formerly een kept secret, but was now revealed to them, and through them to he world (Rom. xvi. 25, 26; 1 Cor. ii. 7-10; Ephes. iii. 9; vi. 19; oloss. i. 26, 27; ii. 2; iv. 3). So Christ said to his disciples, "To you t is given to know the mysteries of the kingdom of heaven, but to hem it is not given" (Matt. xiii. 11; Mark iv. 11; Luke viii. 10), hat is, you are permitted to understand those doctrines which are at resent kept secret from others. But afterwards they were commanded to proclaim these secrets to the world (Matt. x. 26, 27; xxviii. 19, 20; Mark iv. 22; xvi. 15; 1 Cor. iv. 1). It is also applied to individual facts or doctrines. Thus the admission of the Gentiles to the privileges of the Christian religion is called a mystery, because it had never before been understood by the Jews (Rom. xi. 25; Ephes. iii. 3-5). The fact that the living will undergo a change at the resurrection is also called a mystery (1 Cor. xv. 51). To the same class belongs the only passage in which the word might perhaps be understood to imply something not merely *unknown* but actually *incomprehensible,* namely, 1 Tim. iii. 16, "Great is the mystery of godliness (or religion, *εὐσεβείας*); God was manifest in the flesh," &c., which means, "Great is the secret which religion discloses—God was manifest in the flesh," &c. In 2 Thess. ii. 7, "the mystery of wickedness" is "wickedness which is already *secretly* at work in the church," and of which the *revelation* is predicted in ver. 8 (*τὸ γὰρ μυστήριον ἤδη ἐνεργεῖται τῆς ἀνομίας, ... καὶ τότε ἀποκαλυφθήσεται ὁ ἄνομος*). The word is used in rather a singular way, but still with the same meaning, in 1 Cor. xiv. 2, where it is said of a person who speaks in an unknown tongue, "in the spirit he speaketh mysteries," that is, he communes with God in language unintelligible to those around. We have examples of the use of the word to denote the secret meaning of a figure or symbol in Ephes. v. 2; Rev. i. 20; xvii. 5, 7. This general signification of *a secret* is the only one in which the word mystery is used in the New Testament. In the Septuagint its meaning is the same (Daniel ii. 18, 19, 27, 28, 29, 30, 47; iv. 9). The early ecclesiastical writers applied the word to solemn religious rites, and this is probably the reason why *μυστήριον* is translated in the Vulgate by *sacramentum.* In modern usage a *mystery* is a doctrine which is incomprehensible by the human understanding, or which appears to involve facts irreconcileable with each other. Thus the doctrine of the Trinity, the union of the divine and human nature in the person of Christ, the consistency of God's perfect foreknowledge and fixed plan of providence with the free-will of man, are spoken of as mysteries. Not that these doctrines are considered as self-contradictory; for if such contradiction be proved, the doctrine is no longer mysterious but impossible. We believe that they can be explained, though our mental powers are not strong enough to explain them. It is worthy of remark that mysteries (in the modern sense) are found in philosophy and natural religion as well as in revealed religion.

MYSTICS, a Christian sect which arose in the 2nd century, and whose principles are probably to be traced to the philosophy of the Christian Platonists of Alexandria, Ammonius Saccas and his followers. They first appear as a distinct sect in the 4th century, under the teaching of a Grecian fanatic, who gave himself out to be Dionysius the Areopagite, one of St. Paul's converts (Acts, xvii. 34), and who is generally regarded as the founder of the sect of the Mystics.

Adopting the Platonic doctrine, that the human soul is a portion of the divine nature, they held that every man has a divine light within him which is sufficient for his guidance to present and future happiness, but that this light is obscured by the grossness of our material bodies and by the influence of external objects. To shake off these evil influences, and thus to keep the soul in as close connection as possible with its divine original, they considered to be the essence of religion; and this they endeavoured to accomplish by constant meditation on spiritual objects, secret communion with God, and an austere discipline of the body. As they considered everything external to the soul as only calculated to obscure the divine light within, they set no value upon accurate systems of doctrine nor upon religious observances as contributing to the advancement of religion. One of their leading doctrines was that real love to God must necessarily be disinterested, that is, uninfluenced by the expectation of reward or punishment.

The austere lives and apparent devotion of the Mystics caused their principles to spread extensively in the Eastern church, and had a great influence in the spread of monachism. In the 9th century they were introduced into the West by a present which the Grecian emperor Michael Balbus made to Louis le Debonnaire, of the works of Dionysius the Areopagite, which however are undoubtedly spurious. The book was translated into Latin by the order of Louis, and the principles contained in it soon found many followers. In the 13th century the Mystics were the most formidable opponents of the schoolmen, and gradually many eminent men who were disgusted with the puerile conceits and lifeless religion of the latter, attached themselves to the Mystics, or rather to the purely spiritual principles held by them; and just before the Reformation, nearly all the friends of spiritual religion were included in this sect. In the 17th century the doctrines of Mysticism were advocated by a Spanish priest, Michael de Molinos, from whose representations of religion, as consisting in the perfect tranquillity of a mind always engaged in communion with God, the sect obtained the new name of *Quietists.* At the end of the same century attention was called to Mysticism in France by the writings of Madame Guyon, whose sentiments were opposed by Bossuet and defended by Fénélon; and in the next century the Pietists of Germany may be reckoned among them. In all these instances, however, it is more a general resemblance in first principles, than any adoption of the tenets either of Ammonius or Dionysius.

MYTHO'LOGY (*μυθολογία*). The mythology of a people may be said to consist of those legends and traditions which have been, at some period or other, usually believed by the majority of the nation, but which cannot be regarded as historical truths on principles of sound criticism. The term therefore, although chiefly referring to them, is not confined to the religious systems of the Pagan nations; it includes everything that has been an object of popular belief, not merely respecting the origin, attributes, and adventures of the gods, but also concerning the early heroes, migrations, and exploits of a people. The historical inquirer has frequently great difficulty in determining at what time the mythology of a nation may be said to cease, and its history to begin; and in fact it is impossible to determine the exact time, since the transition from mythology to history must be necessarily gradual; and many traditions, which appear at first sight entirely mythological, may, upon further examination, be proved to contain some great historical truths.

Though a mythological event may be fictitious, it appears that mythology differs from fiction or fable, in having been once generally believed by a people as an account of events which actually took place. That which is regarded by us as mythological, may therefore be considered by another people as an historical or religious truth; and in the same manner as the exploits and adventures of the gods and heroes in the Mahâbhârata and Râmâyana are viewed by us as mythological, so the exploits and adventures of the Israelites in the conquest of Canaan, in many respects as extraordinary and wonderful as those of the gods and heroes in the great Hindu poems, may be looked upon by the Brahmans as the mythology of the Christian religion.

On few subjects perhaps has more learning been expended, than in investigating the history and origin of the mythology of the principal nations of antiquity. Among the various theories that have been proposed on this subject, the four following appear to have met with the greatest number of supporters:—

1. *The Scriptural theory,* according to which all mythological legends are derived from the facts contained in the narratives of Scripture, though the real facts have been disguised and somewhat altered. The supporters of this theory maintain that all mythic personages may be found in the Scripture; that Deucalion is only another name for Noah, Hercules for Samson, Arion for Jonah, &c. This hypothesis has been supported with a profusion of learned ingenuity and absurdity by Jacob Bryant, in his 'Analysis of Ancient Mythology,' who saw the patriarchs in every minute event of heathen mythology. Sir William Jones, in his dissertations, in the 'Asiatic Researches,' on the Hindu gods, applied Bryant's arguments to the Hindu mythology, though his good sense preserved him to a great extent from the follies which distinguished Bryant's work. Most of the Christian Fathers maintained that the principal deities in the ancient mythology were in reality devils, and that their worship and history had been taught to mankind by the devils themselves. This theory has been adopted by Milton, in the first book of his 'Paradise Lost,' in those lines beginning with—

> "First Moloch, horrid king, besmeared with blood
> Of human sacrifice, and parents' tears," &c.

2. *The Historical theory,* according to which all the personages mentioned in mythology were once real human beings, and the legends and fabulous traditions relating to them are merely the additions and embellishments of later times. This mode of accounting fo rthe origin of mythology appears to have been in some measure adopted by the Egyptian priests, and was maintained by many of the Greek writers. The Egyptian priests told Herodotus (ii., 144) that their deities originally reigned upon the earth, and that the last who reigned was Orus, the son of Osiris, whom the Greeks called Apollo. An instance of this mode of accounting for the origin of mythology may be seen in the explanation which the Egyptian priests gave to Herodotus of the myth

respecting the foundation of the oracles of Dodona and Ammon, according to which the two black pigeons which came from Thebes, in Egypt, and commanded that the oracles should be established, were in reality two Egyptian priestesses, who had been carried away from Egypt by the Phœnicians, and brought respectively to Dodona and the Libyan desert. Livy also attempts, in a somewhat similar manner, to give an historical explanation of the myth respecting the suckling of Romulus and Remus by a she-wolf (i., 4).

The author of the 'Book of Wisdom' imagines that the heathen deities were originally human beings, and accounts for their becoming objects of religious adoration in the following manner: "For a father afflicted with untimely mourning, when he had made an image of his child soon taken away, now knoweth him as a god, which was then a dead man, and delivered to those that were under him ceremonies and sacrifices.—Whom man could not know in presence, because they dwelt far off, they took the counterfeit of his visage from far, and made an express image of a king, whom they honoured, to the end that by this their forwardness they might flatter him that was absent, as if he were present" (xiv., 15, 17).

Among the Greeks this theory was adopted by Ephorus, and was carried to a great length by Euhemerus, in his 'Sacred History' (ἱερὰ Ἀναγραφή), fragments of which have been preserved by Diodorus Siculus and Eusebius. Some of the Christian fathers also adopted this view of mythology, and employed it with considerable success in their controversies with the supporters of the Pagan religion. Among the moderns this theory has been maintained by Banier, in his 'Mythology and Fables explained by History.'

3. *The Allegorical theory*, according to which all the myths of the ancients were allegorical and symbolical, and contained some moral, religious, or philosophical truth, which was originally represented under the form of an allegory, but became, in process of time, to be understood literally. This view of mythology was first introduced into Greece by the Sophists, and an example of it is given by Protagoras in his explanation of the myth of Prometheus. (Plato, *Protagor.*) In later times this view of mythology was adopted by the New Platonists in their controversies with the Christians; and their object was to show that the ancient mythology, under the garb of allegory, taught all the important duties and doctrines of morality and religion. Thus the view of mythology given by Homer and Hesiod, which was considered by Plato, in his dialogues on the Republic, as mischievous and dangerous, because it attributed human passions and feelings to the gods, occasioned no difficulty with the later Platonists. There is a work of Proclus, of which the curious in such matters may find a translation in the first volume of Taylor's translation of Plato, written for the express purpose of proving, in opposition to Plato, that the mythology of Homer and Hesiod contained nothing contrary to sound principles of morality and religion, since the myths of these poets ought to be understood allegorically.

This method of interpreting the ancient mythology has found much favour among modern writers. It has been adopted by Bacon, in his 'Wisdom of the Ancients;' and has been adopted and carried out to a great extent by Creuzer, in his 'Symbolik und Mythologie der alten Völker, besonders der Griechen,' as well as by Hermann and other recent writers.

4. *The Physical Theory*, according to which the elements, air, fire, water, &c., were originally the objects of religious adoration, and the principal deities were personifications of the powers of nature. Thus the ancient mythology of the Hindus, as developed in the Vedas, personifies the elements and the planets, and differs essentially from the hero worship of later times. The transition from a personification of the elements to the notion of a supernatural being presiding over and governing the different objects of nature was easy and natural; and thus we find in the Greek and Italian mythology that the deities presiding over the sun, the moon, the sea, &c., and not the objects themselves, are the subjects of religious adoration. The Greeks, whose imagination was lively, peopled all nature with invisible beings, and supposed that every object in nature, from the sun and sea to the smallest fountain and rivulet, was under the care of some particular divinity. Wordsworth, in the fourth book of his 'Excursion,' has beautifully developed this view of Grecian mythology.

Almost all the theories that have been brought forward, either in ancient or modern times, to account for the origin of mythology, may be classed under one of these four divisions; but though all of them are true to a certain extent, not one of them taken by itself is sufficient to account for all the mythological traditions of a nation. But among recent authorities a system has been in a great measure developed, which, while borrowing something from each of the systems above noticed, goes deeper than any. It is that which has received the name of Comparative Mythology, and which is correlative with and indeed an integral portion of comparative philology. Like that, finding a close similarity between the myths of widely-dispersed civilised nations, it traces the original forms back to an Asiatic, or, as it is termed, an Arian source; from whence the Sanskrit on the one hand, and on the other the Greek, Italian, Teutonic, and Slavonic languages and traditions, have alike been derived: the myths, like the dialects, varying more and more as they advanced farther from their parent home, and taking in every instance their actual and characteristic shape and colour from their respective nationalities. The virtual identity or common origin of Greek, Sanskrit, and Teutonic mythology, for instance, has been shown by Grimm and others. The myths themselves are in this system regarded as having arisen primarily from either the simple poetical conception and expression of natural phenomena, from animal symbolism, or from the aggregation of subsequent events and circumstances about historical facts, or the deeds of national heroes—these events being often borrowed from neighbouring tribes or people, as well as those of the nation with which the particular tradition or hero may be identified. But myths, to whatever class they belong, were in fact in constant course of growth and embellishment; and as the additions were made without any very nice regard to probability or aptitude, and merely with a view to this aggrandisement of the national deity or hero, they almost inevitably came in course of time to present a congeries of incongruities, contradictions, and absurdities. The separation of the from the primal myth, and their localisation, are among the essential points to be sought after in order to arrive at the original meaning and purpose of the myth itself, as well as the country in which it originated.

The preceding observations are only intended to give a general view of mythology, and of the principal systems which have been proposed in ancient and modern times to account for its origin. The particular mythology of any nation must be acquired by aid of the articles in other parts of this work, such as BRAHMA, VISHNU, FAIRIES, HE GENII, ZEUS, HERA, APOLLO, ARES, &c., and more particularly by the help of such works of reference as are enumerated below.

(*Scriptores Rerum Mythicarum*, edited by Bode; Bochart's *Phaleg and Canaan*; Banier's *Mythology and Fables explained by History*; Bryant's *Analysis of Antient Mythology*; Sir W. Jones, *On the Gods of Greece, Italy, and India*; Rhode, *Ueber religiöse Bildung, Mythologie und Philosophie der Hindus*; K. O. Müller, *Prolegomena zu einer wissenschaftlichen Mythologie*, of which there is an excellent translation by Mr. J. Leitch, *Introduction to a Scientific System of Mythology*; Böttiger, *Ideen zur Kunst Mythologie*; Hermann, *Lehrbuch der Griechischen Antiquitäten*; Gerhard, *Griechische Mythologie*; Lajard, *Recherches sur le Culte public et les Mystères de Mithra en Orient et en Occident*; Buttmann, *Mythologus, oder Abhandlungen und Aufsätze über die Sagen der Griechen, Römer, und Hebräer*; Lobeck, *Aglaophamus, sive de Theologiæ mysticæ Græcorum causis*; Lauer, *System der griechischen Mythologie*; Grimm, *Deutsche Mythologie*; Preller, *Griechische Mythologie*; Nitzsch, *die Sagenpoesie der Griechen kritisch dargestellt*; and Max Müller, *Essay on Comparative Mythology*, in *Oxford Essays*, 1856. The English reader may refer to Keightley's *Mythology of Ancient Greece and Italy*; and Grote's and Thirlwall's *Histories of Greece*.)

N

N is one of the liquid or trembling series of letters. It is formed with the tongue at the point where the teeth and palate meet, and the sound passes chiefly through the nasal passage. For the characters by which this letter is represented, see ALPHABET.

The letter *n* is subject to the following changes:—

1. It is interchangeable with *nd*. Thus the Latin roots *men, fini, gen* (genus), appear in Saxon English as *mind, bind* or *bound, kind* or *kin*. The converse change is common in the provincial dialect of Somersetshire, where the English words *wind, hind* (behind), *find, round, and*, are pronounced *wine, hine, vine, roon, an*; while on the contrary, *manner* is changed to *mander*. [D.]

2. Before *f*, *n* was silent in Latin. Hence the town *Confluentes*, at the junction of the Moselle and Rhine, is now called *Coblenz*. So the German *fünf* is in English *five*.

3. N final often becomes a more complete nasal, and is equivalent to *ng*. Thus the German infinitive in *en* appears to be the parent not only of the participle in *end*, but of the substantive in *ung*, with which are connected the English participle and substantive of the same form in *ing*. The Somersetshire dialect prefers the *n* without *g*, as *stanin, sparklin, starvin*, for *standing, sparkling, starving*. The Sanskrit alphabet has a particular character for this sound.

4. *Ni* or *ne* before a vowel often forms but one syllable with that vowel, the *i* or *e* being pronounced like the initial *y*. This sound is represented in Italian and French by *gn*, as *Signor, Seigneur*; in Spanish by *ñ*, as *Señor*; and in Portuguese by *nh*, as *Senhor*: all derived from the Latin *senior*, elder.

5. *N* is interchangeable with *l*. Hence the double form of *luncheon* and *nunchion*; but see L.

6. *N* with *m*, particularly at the end of words. [M.]

7. *On* and *o* are frequently interchanged. Hence the disappearance of the final *n* in the Latin nominatives *ratio, ordo, Laco*. The Portuguese also often discard an *n* so placed. It is probably from a confusion between the two sounds that the question has arisen, whether the letter *ain* of the Hebrew alphabet is an *o* or an *n*.

8. *R* final perhaps with *rn*. Hence the double forms of the Latin verbs *cer* and *cern*, separate; *ster* and *stern*, strew; *sper* and *spern*, kick, despise. Again *star* (and the Latin must once have had *stera* in order to form from it the diminutive *stella*, as from *puera* comes *puella*) is in German *stern*. *Spur* in the English is *sporn* in German, and of the same origin perhaps is the name of the *Spurn Head*, at the mouth of the Humber, as well as the Latin *spern-ere*. The Latin *bur* (seen in *com-bur-o*) is the same word as the English *burn*; and even the Latin *curr-ere*, to run, has in Gothic the form *urn-an*, just as the south-western dialect of England has *hirn*, and the ordinary English, by a slipping of the *r* [R], *run*. In the same south-western dialect *beforne, avaurn, orn, norn, ourn*, are the forms employed for *before, afore, or* or either (Germ. *oder*) *nor* or neither, *our*. It is, however, not improbable that the *n* so often attached to roots ending in *r* is the remnant of an actual suffix, like the *en* or *on* of our *open, reckon*, or the *αν* of so many Greek verbs, *λαμβανω* for example.

9. *N* with *s*. This change will not be readily admitted without consideration, as the sounds appear so different. The change however is very parallel to the admitted change of *l* and *d*; and indeed as the two latter letters are formed at the same part of the mouth, so are *n* and *s*. The close connection of the two letters will be most forcibly demonstrated by examples of suffixes in which the change occurs. Thus the English language has a double form of the plural suffix in *en* and *es*, as in *oxen* and *asses*. The Greek verb has the same variety; first, in *τυπτομεν* and *τυπτομες*; secondly, in *τυπτετες*, which must have been the older form of *τυπτετε*, and the so-called dual *τυπτετον*. Again the Latin comparative has for its oldest suffix *ios*, as in *melios*, whence both *melior* and *melius*; or a better example occurs in *ple-ios* and *pleos*, whence the latter forms *plous* and *plūs*. On the other hand the Greek suffix is *ion*, as *πλε-ιον* and *πλεον*, from the same root as the Latin *plus*, and with the same meaning. The old genitive plural suffix in Latin appears to have been *sum*, as *servosum*, whence *servorum*; but the Sanskrit often exhibits plural genitives in *nam*. The suffix for a female in Greek is either *na* or *sa*, as *βασιλιννα, μελαινα, λεαινα*, or *βασιλισσα, τυπτουσα*; and in English we have *ess*, while the Germans have *inn*. Lastly, such verbs as *σβεν-νυμι* have *σβεν* for the radical part, which often takes the form *σβες*, as *α-σβεσ-τος*; and the same change appears in *σωφρον*, Nom. *σωφρων* and *σωφροσυνη*. As regards *pōno, posui, positum*, the imperfect tenses are compressed from *pos-n-o* or *pŏs-ĭn-o*, so that this is no example of such interchange.

10. *N* before *s* silent, but lengthening the preceding vowel. This fact is well exemplified throughout the grammar of the Greek language. The Latin had the same peculiarity. Hence *consul* was sometimes written *cosol*, and when abbreviated was always represented by the three first of the sounded letters, namely, *cos*. So *censor, infans, vicies, vicensumus*, are often found in the form *cesor, infas, vicies, vicesimus*. We see too why the Greeks wrote the Latin word *κηνσωρ Κωνσταντινος*, with a long vowel in the first syllable. Lastly, while the Germans write *gans, wünschen*, the English have *goose, wish*.

11. *N* silent at times before *t* and *th*. The English word *mutton* is derived from the French *mouton* and the Italian *montone*; and our word *tooth* in the older Gothic dialects was *tunth*, thus corresponding as nearly as it ought to do with the Greek *οδοντ*, and Latin *dent*.

12. *N* before *v* silent. Thus the Latin *convention*, assembly, became *covention* (as it occurs in one of the oldest inscriptions), before it was reduced to *contion*, the assembly of the people, a word which most modern editors, in spite of all the best MSS. and of etymology, persist in writing with a *c* for the fourth letter. Similarly from *conventu* came the French *couvent*: and though the English generally say *convent*, yet the name *Covent Garden* is a proof that the *n* was not always pronounced even here.

An initial *n* is either prefixed to, or taken from, words by error. Thus *nadder*, a snake, has now lost its *n* through a confusion of the phrase *a nadder* with *an adder*. On the other hand, the phrase *for then once*, that is, *for this once*, in which the article has its old accusative form *then*, is now written *for the nonce*. It is in this way that we should account for the prefixed *n* in the diminutives *Ned, Nol, Nan, Nel*, for *Edmund* or *Edward, Oliver, Anne, Ellen*, as if the original phrases *mine Ed, mine Anne*, had been confounded with *my Ned, my Nan*? At any rate, *mine, thine, an*, were severally the original forms of *my, thy, a*, and used even before consonants; nay, in Somersetshire they have changed *aunt* to *nânt, uncle* to *nuncle, awl* to *nawl*. Very similar is the prevailing error of calling the Greek negative particle *alpha privative* instead of *αν privative*; the latter of which corresponds so accurately with the Latin *in* and the English *un*, to say nothing of the Greek *ανευ*, and the German *ohne*. In fact, *n* at the end of words is often pronounced very faintly.

The Somerset dialect has been referred to because its peculiarities have been recorded with great care in Mr. Jennings's 'Observations.'

NABOB, or NAWAB, a corruption of the Hindustani Nuwwab, which was the title of the governor of a province under the Mogul empire, such as the Nuwwab of Arcot, of Oude, &c. (Gilchrist, 'Vocabulary.') Several of these gradually assumed an independent sovereignty during the decline of the empire, and became either allies or dependents of the Anglo-Indian government. The word Nabob is sometimes used in Europe to mean a wealthy man who has made his fortune in India.

NABONASAR, ÆRA OF. [PERIODS OF REVOLUTION.]

NADIR. [ZENITH.]

NÆVUS (*Nævus maternus, Mother Spot* or *Mole*) is a congenital mark or morbid growth on a part of the skin. Nævi are of various kinds; some are merely yellowish or brown discolorations of the skin without any evident alteration in its structure; but the greater number are composed of an excessively vascular tissue, or a dense network of arteries and veins forming a reddish or livid substance, more or less elevated above the surface of the surrounding skin. A third kind are like extensive warty excrescences, and many of them are covered with thick-set coarse hair.

The nævi of the first kind rarely require treatment. Those of the second are more important from their tendency to increase, or to ulcerate and slough, or to produce severe hæmorrhage by the rupture of some of their vessels. Many plans have been suggested for their removal. If they be not seated on an exposed part, or if they do not show a tendency to increase, they had better be left without treatment. In other cases, the simplest and sometimes a sufficient means is the continued application of cold with moderately firm pressure; but a more certain method is to produce such an inflammation in them as may obliterate their vessels and reduce them to the common substance of scars. In small superficial nævi this may be effected by vaccinating them so as to produce a number of pustules on their surface; and in larger ones, by cauterising a part of their surface with fused potash, or nitric acid, or nitrate of silver, or by injecting some stimulant (as dilute nitric acid) into their tissue, or by making small incisions into them, or by passing hare-lip pins and sutures [HARE-LIP] through parts of their substance, or by placing setons in them. The circumstances of each case must decide the choice between these several means, and the mode in which that which is selected may be best applied. Should complete removal be deemed necessary, nævi may be either cut out, or made to slough by tying them round the base. For the third kind of warty nævi, excision is at once the simplest and most secure means.

It is a popular belief that nævi and some other malformations in infants are consequent on an impression made on the mind of the mother during pregnancy, and that the mark always bears some resemblance to the object by which the impression was excited. It cannot be denied, that among the many cases of nævi, some singular coincidences of the kind have occurred, and that in some of these the malformation might be deemed to have some connection with the object of the mother's fear or anxiety; but till it be determined that the number of these coincidences is greater than would occur according to the common laws of chances (which is as yet far from being proved), the hypothesis of a connection between the state of the mother's mind and the local conformation of the child, which is totally opposed to all physiological probability, cannot be admitted.

NAIADS (Ναιάδες, Νηΐδες) were inferior female deities in the Greek and Roman mythology, who were supposed to preside over rivers, brooks, lakes, and springs: they were in fact the nymphs of the land and fresh-waters, corresponding to the Nereids, or nymphs of the sea. [NEREIDS.] They are represented as young and beautiful nymphs (Hom., 'Od.,' xiii. 103), of whom Ægle, according to Virgil, was the most lovely ('Ecl.' vi. 21). By Greek sculptors they were sometimes represented wholly, sometimes only partially draped, and holding large shells. They are frequently figured with Pan; occasionally with Heracles, sometimes with Zeus. Arethusa, the fountain-nymph, is represented on the coins of Syracuse. Many of the heroes of the Homeric poems are described as the offspring of Naiads.

According to Pausanias (viii. 4, § 2), the Naiads were called, by the Arcadians, Dryades and Epimeliadæ. [NYMPHS.]

NAIL MANUFACTURE. Until a comparatively recent period almost every kind of nail was produced by hand-labour; each nail was separately forged from a thin rod of iron, a process which is still followed in the production of what are technically known as *wrought* nails. As nails so formed possess certain advantages, for particular kinds of work, over those formed either by casting, or by cutting or stamping out of rolled sheet metal, there is no reason to anticipate the total abandonment of this process, notwithstanding the continual improvement of nail-making machinery.

The making of wrought nails, which retains, in most places, the character of a domestic manufacture, forms the employment of a peculiar class of blacksmiths called nailors, who are very frequently assisted by the female members of their families. The nailor receives his iron in the form of narrow square rods, of various sizes, according to the kind of nail to be forged from them. Putting the ends of three or four such rods into the forge-fire at once, the nailor commences his work by withdrawing one when it is properly heated, and forging its end upon a small but very firmly bedded steel anvil to a tapering point. The pointed end is then cut off to the proper length, which is adjusted by a gauge, by laying it across a fixed chisel or *hack-iron*, and giving it a smart blow with the hammer. In some cases, as in making the kind of nail used for fixing horseshoes, this operation completes the nail; but in most instances a subsequent process is necessary to form the head. For this purpose the red-hot spike just cut off from the nail-rod is taken up and dropped, point downwards, into one of the holes of an instrument called a *bore*, which is a piece of iron ten or twelve inches long, with a perforated knob of steel at each end. The holes of this instrument are made to fit the upper or thicker part of the nail, and are so countersunk at their upper ends as to form a kind of mould for the head of the nail. When dropped into one of these holes, a few well-directed strokes of the hammer upon the thick projecting end of the spike or nail converts it into a head of any required shape. In making small nails it is sometimes practicable to forge and cut off two lengths from the nail-rod with one heating; but where this is not the case the nailor is enabled to proceed with his work without interruption by the convenient plan of having several rods in the fire at once, so that as soon as one is cool another is ready to his hand. In many cases, for the sake of economy, two or three nailors work at one hearth, using the same fire and the same bellows in turn; and some hearths have been constructed large enough for five or six men. The hammer used by nailors is larger or smaller, according to the size of the nails to be formed; and its face is inclined considerably upwards towards the handle. Some of the nailors acquire remarkable dexterity. One of them, a few years ago, made 34,000 flooring nails in a fortnight; in performing this task, as each nail required about twenty-five strokes of the hammer, he made, including the cutting up of the nail-rods into convenient lengths, and re-uniting them when they became too short, no less than 1,033,656 strokes, and moved to and from the fire at which the rods were heated 42,836 times.

For some purposes nails formed by the much cheaper process of casting have been long used instead of those wrought in the manner above described. Common cast nails are, however, so clumsy and so brittle that they can only be used for a few coarse purposes, as in plasterer's work, and in the nailing up of fruit-trees. By the introduction of great improvements in the manufacture, however, a very useful kind of cast nail, of an exceedingly pure material called malleable cast iron, has been successfully introduced for certain descriptions of woodwork. Nails of this kind are very neat and regular in their appearance, being cast with great accuracy; and they are annealed to such perfection that the metal will bear far more bending than ordinary wrought-iron without injury. This extraordinary degree of tenacity is, however, obtained at the expense of rigidity, such nails being often nearly as soft as copper, and therefore quite unsuitable for use in hard woods.

The comparatively high price of wrought nails, owing to the great amount of manual labour required in making them, and the insufficiency of cast nails as a substitute for them, has led to the introduction of many highly ingenious machines for forming nails by cutting stamping, or compression, out of plates or rods of rolled iron; with such success that, for the ordinary purposes of the carpenter joiner, cut-nails, varying in size from the smallest tack or brad spikes of six inches or more in length, have almost superseded th wrought by hand. The earliest machine for nail-making was contrived by Mr. French, of Wimborne, Staffordshire, in 17 which no material departure was made from the ordinary process making nails by the hammer; but labour was saved by work hammers by water-power, so that women and children might perf work which would otherwise have required men. The Americans long as the year 1810, possessed a machine which performed cutting and heading at one operation, with sufficient rapidity to out more than 100 nails per minute. In the process now most c monly followed, nails are cut from sheet-iron of suitable thick

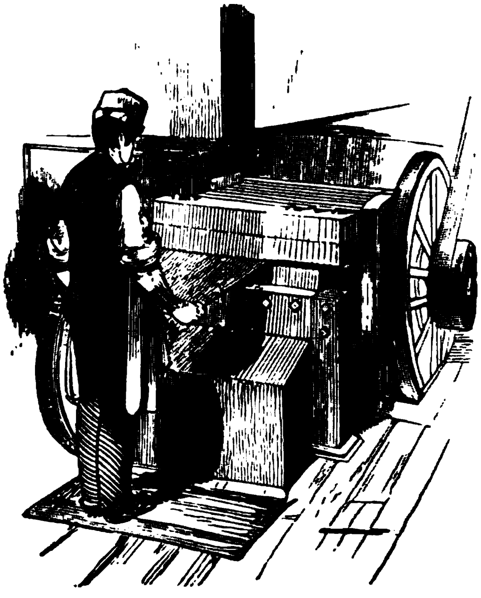


Fig. 1.—Cutting sheets of iron for nails.

The sheet is reduced, by cutting transversely, into strips or ribs of a breadth equal to the intended length of the nails. These st are then applied to a machine in which a chisel-shaped cutter desc with sufficient force to cut off from the end of the strip, at each d

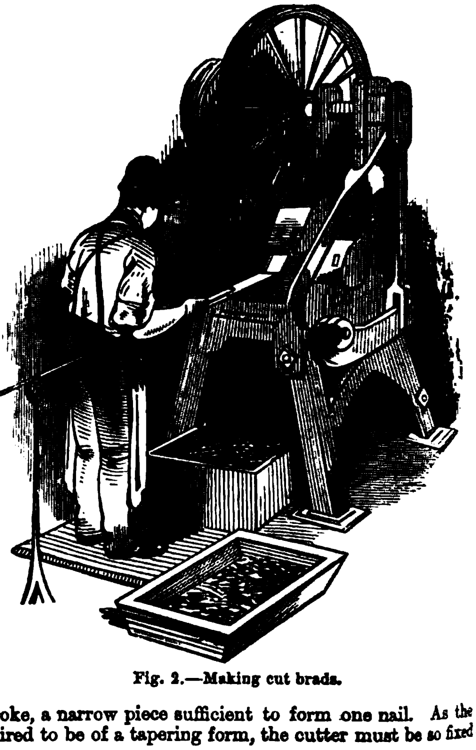


Fig. 2.—Making cut brads.

ward stroke, a narrow piece sufficient to form one nail. As the are required to be of a tapering form, the cutter must be so fixed present a slightly oblique angle to the direction in which the strip is pushed into the machine; and this obliquity must be reversed or varied after each stroke, by means similar to those adopted in comb-cutting machinery. If the nails are to be of any of the kinds to which the term *nail* is specifically applied, as distinguished from *brad*, the action of the cutter is simply reversed, so as to reduce the strip of iron into long wedge-shaped pieces; and the pieces thus separated are subsequently headed by pressure or stamping, so as to form finished nails; but if the nails are to be of the *brad* kind, the action of the cutters must be so modified as to produce cuts alternately at right and oblique angles with the edges of the strip. Nails of this kind need no subsequent heading, but are completed by the action of the cutter. In some machines the cutters do not vibrate or vary their position, but the strip of iron is turned after each cut, so as to produce the same effect. Brads are frequently cut out of hoop-iron instead of transverse strips of sheet-iron, as above described.

Many of the machines recently invented effect improvements in the manufacture of cut nails; while others, intended for wrought nails, are also applicable to the making of bolts, rivets, spikes, nuts, and screw-blanks. The obvious mode of manufacturing these in a rough way is to forge the heated end of an iron rod, and to fashion the metal with the hammer; but the machines now employed increase both the accuracy and the rapidity of the manufacture. One of these machines, invented by Mr. Marrow, of Sheerness Dockyard, is so contrived that it may be put in action by means of a pulley placed upon any moving shaft whatever, whether driven by steam or other power. There are hammers, tappets, &c., connected with the forging part of the mechanism. With one of these machines one man can make sixty half-inch bolts, an inch and a half long, with hexagonal heads, per hour. Mr. Grice's machine, of recent introduction, forms a head on the heated end of an iron rod, converting the rod into a bolt, rivet, spike, or screw-blank. The rod is placed, heated end uppermost, in a die, and by the motion of a bed the rod is brought under a heading-machine, which fashions the head by a pair of dies; another apparatus liberates the bolt or spike; and provision is made for keeping the dies cool by allowing a stream of water to fall on them. Mr. Ward's machine, also introduced within a year or two, is so contrived as to make two bolts or other articles by one revolution of a driving shaft. The machine is fed with iron rods by an attendant; and the metal, whether hot or cold, is cut off and then shaped by dies. There are many other bolt-making machines now in use, some of which fashion the bolt or rivet while in a vertical position, others while horizontal; but it is not necessary to describe them separately. The expediency of making rivets by machinery has now become manifest, since modern engineering, exhibited in such works as the Britannia Bridge and the *Great Eastern* steam-ship, requires rivets by millions at a time. Of the new patents for cut-nails, such as Bowman's, Coates's, Goose's, Poole's, Frearson's, and others, it may be said generally that they relate to minor improvements of some of the processes already described in this article.

Birmingham and its neighbourhood are the great seat of the nail manufacture; wrought nails being made in the villages round about, while cut nails, as well as machine-made bolts, rivets, and spikes, are produced in large factories wrought by steam-power. There are establishments in Birmingham which produce 40,000,000 cut nails per week each,—enough in a year to encompass the earth if placed end to end. A few years ago it was estimated that 25,000 persons were employed in the manufacture; and that 6000 tons of nails were exported, after supplying the home trade.

NAMES. [NOUN.]

NAMES, PROPER, are words by which single objects are denoted, as countries, rivers, towns, men, &c.

But when we speak of proper names, we mean, more usually, the names of men; and on this subject, to which little attention has hitherto been paid, and especially such proper names as appear among ourselves, it is our intention to offer a few observations.

In the primitive state of society, as soon as men were so far advanced as to find the convenience of having a verbal denotation of the individuals who composed a tribe, the rule would undoubtedly be, "one man, one word:" we see this to be the case in the uncivilised tribes; and as man is presented to us in very early historic periods, we still see the same system prevailing. In the Hebrew genealogies, we find a single word, as *Terah, Abraham, Reuben, Aaron, David, Solomon*, the only designation of the persons whom those words call up before us; and if in any instance there is any deviation from the rule, it is for some special reason, and we see it to be an exception to what was the usual practice.

In the other nations, the fathers of European civilisation, it was the same, Egypt, Syria, Persia, and Greece; one person, one word: and so in the earliest periods to which we can ascend in the history of the Latin nation, we have rarely more than one word to denote one individual, or if there is a second word employed, it bespeaks an origin in something which is apart from the simple, colloquial, and usual designation of him.

In the Celtic and German nations it appears to have been the same; *Arminius, Ariovistus*, and the like: and in Britain, *Caractacus*, or *Caradoc*. The Saxons were a nation in whom this, the primitive system, was still prevalent, not only when they first established a colony in Britain, but during the whole period that they held the supreme authority in this island. Persons do, to be sure, present themselves in the pages of historians with such additions as *Harefoot, Ironside*, but it may be reasonably doubted whether these terms can be properly regarded as *names*; and if it is admitted that they may be such, still these are only exceptions, the great mass of the Saxon population, of whatever rank, having but one single word by which the individual was denoted, such as *Edwin, Alfred, Gurth, Ulf, Tosti, Harold*, and the like.

As nations advanced in refinement, the names of the individuals comprising them became more complex. Amongst the Romans, for instance, we have *Publius Cornelius Scipio Africanus, Caius Julius Cæsar, Publius Ovidius Naso;* and names of this class formed the rule, at least in families which were free. The slaves probably remained with the single word only.

We have not room to enter into an examination of the principle on which this new form of personal denomination was constructed. A uniform principle, like that very valuable one on which our own personal nomenclature is at present constructed, perhaps did not exist, so that our present system is rather to be regarded as the invention of modern nations, than as borrowed by them from any of the nations of more ancient civilisation.

The principle of the modern system of personal nomenclature in our own nation is this: to have one name for the individual, joined to a second name, which is common to some particular stirps in the great English family to which he belongs. We call the two the *name* and the *surname*. We think in these days much more of the latter than of the former. But in the more solemn acts of our lives, we find the proper consequence given to that which is indeed the name; in baptism, in elementary Christian instruction, at marriage, when the name is the thing in question, it is that which is properly the name, and not the surname, which is pronounced; *John, Richard, Anne*. We may find in books, even down to the close of the 17th century, that catalogues and indexes are sometimes so constructed, that the names, and not the surnames, are ranged in alphabetical order. Philips's 'Theatrum Poetarum' presents a late instance.

The value of this principle lies here: that it is a simple and easy mode of showing, to some extent, to what family an individual belongs; it promotes family union; but its chief advantage lies in the facilities which it affords for conducting inquiries into the condition of the ancestors of persons who may feel any curiosity on the subject, which, without the indications afforded by identity of surname, could be attended with very little success, when it was attempted to ascend beyond the recollections of persons still living.

This mode of designation, we believe, prevails in most other countries of modern Europe. In England it is almost the universal plan. The royal house of England forms an exception, an unchangeable surname having never been adopted by them. In this respect the house of Brunswick is like the houses of Saxe, Nassau, Bourbon, Orleans, and a few others, springing from the persons who were of prime note in that state of society when the rule was, "one person, one word," and being afterwards too conspicuous by rank and station to need any such ordinary mode of distinction as that which the adoption of an invariable addition to the name would have given them. This was once not peculiar to the royal house of England in this island (the Stuarts, it may be observed, and perhaps the Tudors, but not the Plantagenets, were a temporary exception, being families of inferior rank, who were raised by circumstances to the possession of the regal dignity), for the earls, in the first two or three centuries, seem also to have disdained a practice which assimilated them too nearly to the classes next below them. Thus the persons distinguished in Domesday Book as *Comites*, are *Comes Hugo, Comes Rogerus;* and never, we believe, with names of addition which descended to their posterity. But all these great houses have become long ago extinct.

There is also an exception to the modern rule, of another kind. There are still some remote and rudely-cultivated districts, in which the inhabitants are better known by some *by name*, as of the house in which they live, or as the son of some person well-known, than by any unvarying addition to their name properly so called. This is said still (or at least no great while since) to be the case in some parts of Yorkshire and Lancashire, and is certainly the case in parts of Wales, but it is probable that the extension of education will bring all parts of this island into subjugation to a plan which has such obvious convenience.

If it is inquired when the system on which we now proceed was first adopted, the fact which has just been stated, that even now the system is not universally prevalent, will show, what is indeed the fact, that, like many other things, it has made its way by degrees. There is not, we believe, a single instance before the Conquest of persons in genealogical succession bearing the same surname; and it is also quite certain that in the mass of the population of England after the Conquest, the descendants of the Saxon population, there can rarely, if ever, be shown an instance of successive individuals of the same family being distinguished by the same surname in the two centuries immediately succeeding the Conquest. We have indeed but imperfect means of pursuing the inquiry for those two centuries. The names of the people of those centuries lie buried in unprinted records and chartularies. But if there are exceptions, and Saxon families in these centuries to be traced using an invariable as well as a variable name, it is in that remarkable class, who still exist in no very small number, who have one of the old Saxon appellatives in the place of the surname, such as *Thorold*, *Swaine*, *Aldred*, *Thoroughgood* (Turgot), *Godwin*, and the like.

But we find in Domesday Book that several of the Normans and other people from the Continent, who became settled in England at the Conquest, and soon after that event, are distinguished by names of addition, which are not merely personal, but names which were borne by themselves and their posterity after them. Such are *Darcy*, *Arundel*, *Devereux*, *Balliol*, *Burun*, *Laci*, *Perci*, and others, people just below the rank of the comites, and who, gaining great possessions and great power, were afterwards very conspicuous in English history. These are the persons, we conceive, who first set the example of the practice which has since beome all but universal among us.

The disposition which always more or less exists to imitate what is done by a superior, is probably the principle to which we are to refer the change in this point which we find to have taken place by the middle of the 14th century.

By that time the present system may be said to have been pretty generally established in all the well-settled portions of the island. The statute of additions of the 1st Henry V., by requiring that the name and description of the party should be exactly set forth in any writ or indenture, would do something to consolidate the system; and when it was required that in all parishes a register should be kept of baptisms, marriages, and burials, which was one of the acts of the Reformers, there was a new check presented to any attempts at relaxation in the practice.

But even at the beginning of the 15th century there was much that was unsettled in the personal nomenclature of England, even in families to whom pertained portions of the soil. Thus in 1406 a person describes himself as *Willielmus filius Adæ Emmotson*, who in 1416 is *Willielmus Emmotson*; and more remarkably about the same time, a person who is described as *Johannes filius Willielmi filii Johannis de Hunshelf* appears soon after as *Johannes Wilson*. About the same time we had *Willielmus Johnson Wilkinson*, *Willielmus Adamson Magotson*, and *Thomas Henson Magot*, showing the present system then in its rudiments.

As the system at present existing made its way by degrees, and with much of casualty, so there seems to have been much also of accident in respect of the name of addition which marked the distinction of the stirpes. There are some of the surnames in common use among us for the adoption of which it is difficult now to assign any satisfactory reason. This is partly to be attributed to the corruption which many names have undergone, and partly to the strange additions which we find in the place of surnames in early documents of undoubted authenticity. One of these is *Adam that God made*, whose addition, if he lived at the period when his race first began to conform themselves to the system, would appear now in some form which would probably foil the sagacity of the most skilful inquirer. Sometimes there is a difficulty arising out of a wrong apprehension of the origin. Thus we have the names *Spring*, *Summer*, *Winter*; there is no *Autumn*. It is difficult to conceive how the names of the seasons should become the names of families; but in fact it is not so, *Spring* being a word denoting a small grove of trees, so that the name classes with *Wood*, *Holt*, and others concerning which there is no difficulty; while *Summer* and *Winter* are *Summoner* and *Vintner*, names derived from occupations.

But the great mass of our surnames may be easily explained. We cannot enter here at large into the subject; but it may be useful to those who are inclined to prosecute it, to say that nearly the whole of them may be referred to one of the five following classes:—

1. Foreign names brought in by settlers from other countries, including the Scotch and Irish names. These designate a very large section of the whole population; and there is a constant accession being made to them by the tide of population setting towards England. Very few of the names of this class introduced in the early periods remain: the great majority being of families who have become settled in England in the course of the last century and a half.

2. Names of locality.—These are divisible into two great portions: those which are derived from places of generic names only, such as *Hill*, *Dale*, *Cliff*, *Slack*, *Combe*, *Grove*, *Shaw*, *Frith*, and many others, mostly monosyllabic, which would originally appear as *John de la Hill*, &c.; and those which are derived from some specific place, as *Atherton*, *Burton*, *Denby*, and thousands of others, there being scarcely a town, village, or hamlet which has not given its name to some English family.

3. Names of occupation.—Of this class the number is very great. We have *Brewer*, *Barber*, *Smith*, *Mason*, in short every trade and every other occupation in which men engage. Lost trades or trades which have changed their names are preserved in the names of families whose ancestor was engaged in them at the time when his family fell into the system. Thus we have *Fletcher*, *Girdler*, *Furbisher*, *Stringfellow*, *Lister*, *Walker*, *Pargiter*, *Webster*, *Taverner*, and the like. We have also *Palliser*, *Lander*, *Foster*, *Palfreyman*, *Page*, *Woodruffe*, *Reeve*, *Hunter*, which were evidently at the beginning names of occupation. It is difficult to account for such names as *Bishop*, *Baron*, *Earl*, *Lord*, *Priest*, *King*.

4. A large portion of our personal nomenclature is made up of surnames which are formed upon those which we call Christian names. Nearly all these appeared originally in the form of *Filius*, &c., as John son of William. This mode of designation has taken various forms. Thus on this name of *William*, there are founded *Williams*, *Williamson*, *Wills*, *Wilson*, *Wilks*, *Wilkins*, *Wilkinson*, *Willis*, *Willison*, *Bill*, *Bilson*, *Willet*, *Willimot*, *Willmot*, *Till*, *Tilly*, *Tillot*, *Tilson*, *Tillotson*, *Will*, each of which, if written by a scribe of the middle ages in Latin, would be expressed by the same phrase *Filius Willielmi*. Other names have an equally numerous progeny. To this class may be referred *Ives* and *Iveson* which are *Filius Judei*; *Clarkson*, *Cookson*, *Wrightson*, which are names formed not indeed on the name, but the profession of the parents.

It would however be to extend this article to an inordinate length, even to touch upon the subordinate classes to the five great classes.

5. The fifth and last is that of names which indicate something peculiar in the personal appearance or mental qualities of the persons to whom they are first given. Such are *Swift*, *Long*, *White*, *Black*, *Crump*, *Rouse*, *Wise*, *Good*, &c.

The *names* of the ancient Saxon population of England were nearly all descriptive of some quality of mind or body. Thus *Edward* is truth-keeper; *Winfred*, win-peace; *Alfred*, all-peace; *Edmund*, truth-mouth; *Ailwin*, of all beloved; *Ulf*, wolf. But a great change took place soon after the Conquest. We see in the names of the Normans who became settled in England many which continued for ages favourite names of the English nation; *Roger*, *Ralph*, *Hugh*, *Humphry*, *Jeffrey*, *Gilbert*. To them also we owe the introduction amongst us of names of religion. If these names existed at all in England before the Conquest, they were exceedingly rare. In the catalogues of Saxon bishops, not one occurs. Even amongst the first race of Normans they did not abound. We find *Adam*, *John*, *Stephen*, *David*, *Peter*, *Matthew*, and perhaps a few others. But in the century and a half after that event, names of this class began to prevail in a great degree. It was a period of extraordinary Christian devotion: the exertions in founding monasteries, building churches, and maintaining the war against the infidels show it. In this state of the public mind the new system of taking names of religion spread and strengthened. The names of religion were almost wholly from the Old and New Testament, a few only being taken from the names of persons who have been eminent in later times for their Christian virtues.

Since then little change has taken place. A few names once common have lost their popularity; a few others have been introduced. There have been periods when names somewhat fantastic have had a popularity; such as the names of the virtues, as *Patience*, *Truth*, *Prudence*, *Faith*, by which women have been named; *Thankful*, *Faithful*, *Sabbath*, and others more extraordinary, have been given to men. Some went for a time into another extreme, and we had *Hannibal*, *Scipio*, *Cæsar*, *Hercules*.

We have however not been sufficiently attentive to the importance of keeping up a stock of what we call Christian names. Our population has increased to a very great extent, while our surnames have rather diminished than the contrary. We should therefore, if we wish that names should be what they are intended to be, *Notamina*, increase the number of those names out of which we have the power ourselves of selection. As it is, with a population of 30 millions, we have but 53 names of men which can be used without some appearance of singularity. Of these 12 are in more frequent use than the rest:—

John	William	Henry	George	James	Robert
Thomas	Francis	Charles	Edward	Richard	Samuel

Of these, 4 are names of religion; 4 are names introduced at the Conquest; 3 names introduced at a later period from the nomenclature of other countries; 1 is pure Saxon. Of the 41 names of secondary frequency, 28 are names of religion; so that of the 53 names of men in ordinary use, 32 are names of religion, or considerably more than one-half, and they are all taken from the Scriptures.

Again, looking at the 53 names in respect of the languages from which they are derived, it appears that

25 are of Hebrew origin,
19 from the various dialects of Western Europe,
5 from the Greek, and
4 from the Latin.

There are a multitude of names, once in use in England, which might easily be revived, and it would be a matter of some public convenience to do so. Few persons have not found inconveniences in some form or other from the want of sufficient distinctness in the name he bears. Thus a little time ago there were two antiquarian Chalmers'; two Parkes upon the bench; two Whitakers, both clergymen, and both writers on Lancashire topography: some time ago there were two Dr. John Thomas's, both chaplains to the king, and both bishops; and two Dr. Grays, both divines, both writers in their own profession, both connected with historic literature and poetry, and both engaged in controversies with Warburton. This occasions confusion. To change a surname is a difficult and expensive process; the cheapest and simplest remedy is to give a name at baptism which will be marked and remembered, as *Basil Hall*. Of neglected names there are, *Austin*, *Allan*, *Aubrey*, *Arnold*, *Baldwin*, *Blase*, *Barnard*, *Fabian, Ferdinand, Josceline, Miles, Sylvester, Theobald, Theodore,* and a ost of others.

Some further information of a curious nature will be found in an Essay on Surnames,' by M. A. Lower.

NANKEEN, a kind of cotton cloth, usually of a yellow colour, imported from China, and taking its name from the city of Nankin, in which great quantities are made. The peculiar colour is natural to the cotton-wool of which the nankeen is made, and not the effect of any ye. White cloth of similar texture is imported from China; and his, to distinguish it from the yellow kind, is called white nankeen. Nankeen cloth was formerly very much used in England for gentlemen's summer clothing; but better fabrics of home manufacture being now procurable at lower prices, these have taken the place of the Chinese goods.

NAPHTHA. The word naphtha is derived from the oriental term *nafata,* signifying to ooze out, and was originally applied to a yellowish-white, volatile, inflammable, liquid hydrocarbon, which exudes from the soil in certain parts of Persia, Italy, &c. The very fluid portions of those natural tar-like matters [Asphalt; Bitumen; Petroleum] that issue from the ground in so many parts of the world, having been found to be almost identical with the original nafata, have been included under the term naphtha, and the latter word is therefore, or rather should be, now used to designate any light, more or less colourless, inflammable fluid, of mineral origin and immiscible with water. Naphtha is sometimes specifically termed *mineral naphtha.*

Other liquids, resembling true naphtha in little else than the characters of volatility and inflammability, have also been called naphtha. Thus wood-spirit has frequently been so named, and is still often spoken of as *wood-naphtha;* see Methyl, *hydrated oxide of.* Acetone is also sometimes described under the name of naphtha. Lastly, Coal Tar yields by distillation a liquid having all the characters of natural naphtha; it is, however, generally distinguished as *coal naphtha.*

The origin of naphtha is, in all probability, due to the action of internal heat upon beds of coal or peat, these substances being, in nearly all cases, found in the neighbourhood of the petroleum or naphtha springs; moreover, the artificial production of coal naphtha, as just described, gives considerable support to this theory.

Crude naphtha is usually contaminated with much colouring matter, but from this it may be freed by rectification. When quite pure it contains no oxygen, and hence is usually the liquid in which potassium, sodium, and other metals that have intense affinity for oxygen are preserved. For the latter purpose it must be several times well agitated with about a fifth of its bulk of strong sulphuric acid, then washed with water, and finally distilled from quicklime.

Pure naphtha is colourless, and of peculiar taste and odour. It is insoluble in water; soluble in about eight parts of alcohol; and miscible in all proportions with ether, and with the essential oils. With the aid of heat it dissolves one-fourteenth of its weight of phosphorus, or one-twelfth of sulphur, but deposits them on cooling. It dissolves one-eighth of its weight of iodine, absorbs ammoniacal and hydrochloric acid gases, is attacked by chlorine and bromine, and decomposed by hot concentrated nitric or sulphuric acids. It is an excellent solvent for gutta percha, india-rubber, camphor, and oily or resinous bodies generally; is indeed largely used for these purposes, but chiefly in lamps as a source of artificial light. Its specific gravity varies from 0·7 to 0·85.

Naphtha seems to be a mixture of several polymeric hydrocarbons. Pelletier and Walter have extracted and described three, namely, *naphtha* ($C_{14}H_{13}$), boiling point 190°; *naphthene* ($C_{16}H_{16}$), boiling point 239°; and *naphthole* ($C_{24}H_{22}$), boiling point 374°.

Great care should be observed in manipulating with the more volatile descriptions of naphtha. It is exceedingly inflammable, and fatal accidents have arisen from its vapour catching fire on the approach of a naked flame.

For the chief localities of the naphtha springs, and statistics concerning their products, see Naphtha, in Nat. Hist. Div.

NAPHTHALAMIDE. [Naphthalic Group.]

NAPHTHALASE. [Naphthalic Group.]

NAPHTHALENE. [Naphthalic Group.]

NAPHTHALIC ACID. [Naphthalic Group.]

NAPHTHALIC GROUP, a division of the Benzoic series of organic compounds. It is chiefly composed of the derivatives of napththalin.

Naphthalin ($C_{20}H_8$), or *hydride of naphthyl* ($C_{20}H_7$, H), or *naphthalene,* was first discovered by Garden in coal tar. Faraday determined its composition, and Laurent has particularly investigated its constitution. It is a very common product of the decomposition of organic bodies by heat, but its most abundant source is coal-tar. Large quantities of it are produced at all gas-works, and its separation from the tar may be accomplished by the following process:—After exposure to air for some time the tar is redistilled; the first portion of the distillate is set aside, the second portion furnishes much naphthalin if artificially cooled, but the last portion comes over in an almost semi-solid state, and on standing for a short time sets into a solid mass of crystals of naphthalin. Much oily matter is got rid of on submitting the mass to pressure, and the naphtha is finally obtained in a pure state by successive sublimations or recrystallisations from alcohol.

Naphthalin is colourless, has a somewhat tarry odour, and a burning aromatic taste. It crystallises in large, thin, rhombic plates of pearly lustre, and unctuous feel. Exposed to light under a glass covering, it gradually sublimes in magnificent crystals, and altogether presents a very beautiful appearance. It fuses when heated to 174° Fahr., and boils at 428°. Its vapour density is 4·582. It is not very inflammable, and when ignited gives off much smoke. It is very volatile in vapour of water. It is insoluble in cold water, very slightly soluble in hot water, but readily so in alcohol, ether, and the fixed and essential oils. It appears also to be soluble in acetic or oxalic acids, but is not acted upon by caustic potash.

Sulphuric derivatives of Naphthalin.

Sulphonaphthalic acid ($C_{20}H_8S_2O_6 + 2Aq.$). ***Naphthyl-sulphurous acid, hyposulphonaphthalic acid,*** or ***naphthyl-dithionic acid.*** Obtained by acting upon naphthalin with excess of sulphuric acid at a temperature not exceeding 200° Fahr.; it crystallises on cooling. It is very soluble in water, alcohol, and oils, but only slightly so in ether. It has an acid, astringent, metallic taste, and at a high temperature is decomposed. The *sulphonaphthalates* are monobasic; those of the alkalies are readily obtained in crystals. By substitution processes, the following compounds of sulphonaphthalic acid are easily produced; they all form salts with bases, several of the compounds being crystalline:—

Chlor-sulphonaphthalic acid	$C_{20}H_7ClS_2O_6$
Brom-sulphonaphthalic acid	$C_{20}H_7BrS_2O_6$
Bichlor-sulphonaphthalic acid	$C_{20}H_6Cl_2S_2O_6$
Bibrom-sulphonaphthalic acid	$C_{20}H_6Br_2S_2O_6$
Trichlor-sulphonaphthalic acid	$C_{20}H_5Cl_3S_2O_6$
Quadrichlor-sulphonaphthalic acid	$C_{20}H_4Cl_4S_2O_6$
Nitro-sulphonaphthal(or theo)ic acid	$C_{20}H_7(NO_4)S_2O_6$
Binitro-sulphonaphthalic acid	$C_{20}H_6(NO_4)_2S_2O_6$

Disulphonaphthalic acid ($C_{20}H_8S_4O_{12}$). ***Thionaphthic acid,*** or ***hyposulphonaphthinic acid.*** This acid is produced under circumstances similar to those under which sulphonaphthalic acid is obtained, but at a higher temperature; fuming sulphuric acid also facilitates the reaction. It is dibasic. Both it and its salts crystallise with difficulty.

Sulphonaphthalin ($C_{40}H_{14}S_2O_4 = C_{20}H_8 + HO, SO_3 - 2HO$). Produced when vapours of anhydrous sulphuric acid are passed into fused naphthalin, the latter being kept in excess. It is a granular body, slightly soluble in water, but more so in alcohol. It is sometimes accompanied by ***sulphoglutinic acid*** (hyposulphoglutinic acid).

Nitro-derivatives of Naphthalin.

Nitronaphthalin ($C_{20}H_7(NO_4)$). *Nitronaphthalase.* Naphthalin is well stirred with five times its weight of cold nitric acid of sp. gr. 1·33. After some days it is found converted into a lemon-yellow mass of nitronaphthalin, insoluble in water, but soluble in hot alcohol or ether, the solutions depositing it in brittle needles on cooling. Heated with lime, it disengages ammonia, and, among other products, yields a substance called by Laurent *naphthalase,* or, better, ***naphthase.***

Binitronaphthalin ($C_{20}H_6(NO_4)_2$). *Nitronaphthalese.* Naphthalin added to hot strong nitric acid is converted into the above compound, which crystallises out on cooling in pale yellow needles. It is only slightly soluble in alcohol or ether. Boiled with alcoholic solution of potash, ammonia is disengaged, and nitric acid then precipitates, from the solution, dark brown flocks of *nitronaphthalesic acid.*

Bromo-binitronaphthalin ($C_{20}H_5Br(NO_4)_2$). A crystalline body formed on dissolving bibromonaphthalin in nitric acid.

Trinitronaphthalin ($C_{20}H_5(NO_4)_3$). *Nitronaphthalise.* This compound occurs under three isomeric modifications. It is obtained on boiling naphthalin for some days in nitric acid. It is colourless, and crystallises in irregular tables or prisms. Alkalies colour it red.

The final product of the prolonged action of nitric acid upon naphthalin is a mixture of oxalic and phthalic acids, thus:—

$$\underbrace{C_{20}H_8}_{\text{Naphthalin.}} + \underbrace{O_{16}}_{\text{Oxygen.}} = \underbrace{2HO, C_{16}H_4O_6}_{\text{Phthalic acid.}} + \underbrace{2HO, C_4O_6}_{\text{Oxalic acid.}}$$

Phthalic acid ($C_{16}H_6O_8 = 2HO, C_{16}H_4O_6$). *Naphthalic acid.* ***Alizaric acid.*** In addition to the method just mentioned, this acid results from the long-continued action of nitric acid upon bichloride of naphthalin, alizarin, or purpurin. [Madder, Colouring Matters of.] It may be obtained in the pure state by repeated crystallisation from water, and then forms lamellar groups. It is very soluble in alcohol or ether. By distillation with lime it is converted into carbonic acid and Benzole, and when heated alone it sublimes in beautiful elastic needles of *phthalic anhydride* ($C_{16}H_4O_6$), called also *anhydrous phthalic acid,* and *pyroalizaric* acid. It is a bibasic acid, and forms neutral and acid *phthalates.*

Trichlorophthalic acid ($C_{16}H_3Cl_3O_8$), *chlorophthalisic acid* is produced by the action of nitric acid upon sexchlornaphthalin.

Nitrophthalic acid ($C_{16}H_5(NO_4)O_8$) may be obtained in yellowish rhomboidal crystals by evaporation of the mother liquors from the preparation of the nitronaphthalins. It is bibasic, and forms crystalline salts. By sublimation it is reduced to the anhydrous condition.

Phthalamic acid, or *naphthalamide phthalamide* ($C_{16}H_7NO_6$), results from the action of ammonia upon anhydrous phthalic acid.

Phthalimide, or *naphthalimide* ($C_{16}H_5NO_4$), sublimes in thin plates when acid phthalate of ammonia is heated. It is colourless, almost insoluble in water, but readily soluble in boiling alcohol or ether.

Phenyl-phthalimide, or *phthalanile* ($C_{28}H_9NO_4$), is produced by the action of aniline upon ammonia. *Phenyl-phthalamic acid*, or *phthalanilic acid*, contains ($C_{28}H_{11}NO_6 = C_{16}H_6(C_{12}H_5)NO_6$).

Chlorine and Bromine derivatives of Naphthalin.

These are extremely numerous, and are of two kinds. First, those which are simply naphthalins ($C_{20}H_8$), in which an atom or atoms of hydrogen are replaced by equal quantities of chlorine or of bromine. The following is a list of them:—

Chlor-naphthalin (chlonaphtase)	$C_{20}H_7Cl$
Brom-naphthalin (bronaphtase)	$C_{20}H_7Br$
Bichlor-naphthalin (chlonaphtese) . . .	$C_{20}H_6Cl_2$
Bibrom-naphthalin (bronaphtese)	$C_{20}H_6Br_2$
Trichlor-naphthalin (chlonaphtise) . . .	$C_{20}H_5Cl_3$
Tribrom-naphthalin (bronaphtise)	$C_{20}H_5Br_3$
Bromo-bichlor-naphthalin (chlorebronaphtise) .	$C_{20}H_5Cl_2Br$
Quadrichlor-naphthalin (chlonaphtose) . .	$C_{20}H_4Cl_4$
Bromo-trichlor-naphthalin (chloribronaphtose) .	$C_{20}H_4Cl_3Br$
Bibromo-bichlor-naphthalin (chlorebronaphtose) .	$C_{20}H_4Cl_2Br_2$
Quadribrom-naphthalin (bronaphtose) . . .	$C_{20}H_4Br_4$
Bibrom-trichlor-naphthalin (bromechlonaphtuse) .	$C_{20}H_3Cl_3Br_2$
Sexchlor-naphthalin (chlonaphthalase) . . .	$C_{20}H_2Cl_6$
Perchlor-naphthalin (chlonaphthalise) . . .	$C_{20}Cl_8$

Several of the above compounds exist in seven, or less, distinct modifications; Laurent, the completeness of whose researches on these bodies is only equalled by their importance, accounts for this fact by supposing that each of the eight equivalents of hydrogen in naphthalin has its allotted position, and that according as one or other is replaced by the chlorine or the bromine so do the properties of the resulting compound differ.

In naming the many derivatives of naphthalin, Laurent adopted the word *napht* as the root, prefixing it by *chlo*, *bro*, &c., to indicate the substituting element; and introducing the vowels, *a*, *e*, *i*, *o*, *u*, when it was necessary to show that one, two, three, four, or five atoms of the element had been taken into the compound molecule. When more than five replacing atoms were employed, the syllable *al* was introduced, and the use of the vowels recommenced. Numerous examples of this useful, though scarcely euphonical, nomenclature will be observed throughout the article.

The second class of chlorine and bromine derivatives of naphthalin are combinations of the compounds just described, with additional equivalents of chlorine or bromine, ordinary *chlorides* and *bromides* resulting. They are nearly all formed by the direct action of chlorine or bromine upon the different naphthalins. When acted upon by alcoholic solution of potash, they are split up into hydrochloric or hydrobromic acids, and the chlor- and brom-naphthalins already mentioned. The following is a list of these chlorides and bromides of naphthalin, or of its derivatives:—

Chloride of naphthalin	$C_{20}H_8, Cl_2$
„ brom-naphthalin	$C_{20}H_7Br, Cl_2$
Bromide of tribrom-naphthalin . . .	$C_{20}H_5Br_3, Br_2$
Bichloride of naphthalin	$C_{20}H_8, 2Cl_2$
Bichlorobromide of naphthalin . . .	$C_{20}H_8, Cl_2Br$
Bichloride of chlor-naphthalin . . .	$C_{20}H_7Cl, 2Cl_2$
„ bichlor-naphthalin . .	$C_{20}H_6Cl_2, 2Cl_2$
„ bibrom-naphthalin . . .	$C_{20}H_6Br_2, 2Cl_2$
Bibromide of bichlor-naphthalin . .	$C_{20}H_6Cl_2, 2Br_2$
„ bromochlor-naphthalin . .	$C_{20}H_6BrCl, 2Br_2$
„ bibrom-naphthalin . .	$C_{20}H_6Br_2, 2Br_2$
Bichloride of bibrom-chlor-naphthalin . .	$C_{20}H_5Br_2Cl, 2Cl_2$
Bibromide of tribrom-naphthalin . .	$C_{20}H_5Br_3, 2Br_2$

Paranaphthalin, or *anthracin* ($C_{30}H_{12}$)? This polymeride of naphthalin accompanies the latter body towards the end of the process of distilling coal-tar. It is insoluble in alcohol; any naphthalin is therefore easily dissolved out by that liquid. It is a white solid; melting point 356° Fahr. At a temperature above 572°, it boils, sublimes, and condenses in lamellar crystals. Turpentine readily dissolves it. Chlorine converts it into *chloranthacin*, a crystalline body containing $C_{30}H_{10}Cl_2$. A corresponding nitric derivative, $C_{30}H_{10}(NO_4)_2$, also exists.

Metanaphthalin, or *retisterin*, is another polymeride of naphthalin, obtained during the distillation of rosin. Its melting-point is 153° Fahr., boiling point 617°. It is crystalline, slightly soluble in cold alcohol, but readily so when heated; it is also soluble in ether, naphtha, and turpentine.

Naphthylamine ($C_{20}H_9N = NH_2(C_{20}H_7)$). *Naphthalidam*. *Naphthalidine*. Obtained by the reduction of nitronaphthalin, either
acetic acid and metallic iron, or with sulphide of ammonium.

$$\underbrace{C_{20}H_7(NO_4)}_{\text{Nitronaphthalin.}} + \underbrace{6HS}_{\text{Sulphuretted hydrogen.}} = \underbrace{C_{20}H_9N}_{\text{Naphthylamine.}} + \underbrace{4HO}_{\text{Water.}} + \underbrace{S_6}_{\text{Sulphur.}}$$

Naphthylamine forms white, silky needles. It melts at 122° F
and at 572° sublimes without alteration. It has a disagreeab
and bitter taste, is almost insoluble in water, but very soluble in al
or ether. It combines with acids to form white crystalline salts.
hydrochlorate contains $C_{20}H_9N,HCl$; the *nitrate* $C_{20}H_9N,NHO_6$;
neutral oxalate $2C_{20}H_9N, C_4O_6$, 2HO: and the *acid oxalate* C_2
C_4O_6, 2HO. Dr. Schiff has also recently ('Ann. Chem. Pharm.'
obtained the following derivatives of naphthylamine. *Iodide of*
naphthylammonium ($N(C_4H_5), (C_{20}H_7)H_2, I$); shining four-sided pr
Bromide of ethyl-naphthylammonium ($N(C_4H_5), (C_{20}H_7H_2, Br)$); a
crystals. *Naphthyl-urea* ($C_2H_3(C_{20}H_7)N_2O_2$); shining, flat nee
Bromide of naphthylammonium ($NH_3(C_{20}H_7), Br.$) *Oxynaphth*
($NH_3(C_{20}H_7), O_2$), produced by the characteristic reaction of nap
lamine with perchloride of iron, chlorides of gold, platinum, mer
zinc, chromic acid, or nitrate of silver. It is the substance
naphthomein by Piria. *Dinaphthyl-sulphocarbamide* ($NH_2(C_2$
C_2S_2) obtained on heating naphthylamine with bisulphide of
in a sealed tube for some hours. By heating naphthylsulpho-ca
mide with anhydrous phosphoric acid, Mr. Hall has produced
cyanide of naphthyl ($C_{20}H_7, C_2NS_2$). *Naphthylcarbamide*, obtain
the action of potash on naphthylsulphocarbamide, is also powe
attacked by anhydrous phosphoric acid and yields, among other b
Cyanate of naphthyl ($C_{20}H_7,C_2NO_2$). Hyponitrous acid acts upon
thylamin, and gives rise to *Nitroso-naphthylin*, a purple substan
taining, according to Church and Perkin, ($C_{20}H_8(NO_2)N$): it s
what resembles Laurent's *carminaphte* obtained by the action of ch
acid upon naphthalin.

Nitronaphthylamine ($C_{20}H_8(NO_4)N$) is a nitric derivative of na
lamine obtained on treating binitronanaphthalin with sulphu
hydrogen, the ultimate product, however, is

Azonaphthylamine, or *seminaphthalidam* ($C_{20}H_{10}N_2$). The fol
equation explains its formation:—

$$\underbrace{C_{20}H_6(NO_4)_2}_{\text{Binitronaphthalin.}} + 12HS = \underbrace{C_{20}H_{10}N_2}_{\text{Azonaphthylamine.}} + 8HO + S_{12}$$

It is deposited from alcohol in long, brilliant needles. Its sal
crystalline, and have mostly an acid constitution.

Thionaphthamic acid ($C_{20}H_9NS_2O_6$) and *naphthionic* (or sulph
thalidamic) *acid* ($C_{20}H_9NS_2O_6$) are isomeric sulphuric derivativ
naphthylamine. They form crystallisable salts with bases.

Oxynaphthalic acid ($C_{20}H_6O_6$). This substance has not yet
produced (unless alizarin be identical with it), but two derivative
it, containing respectively one and five equivalents of chlorine in
place of one and five of the hydrogen in the above formulæ, are
known.

By the action of nitric acid upon bichloride of chlornaphthal
obtain *chloride of chloroxynaphthyl* ($C_{20}H_4Cl_2O_4$) called also *oxy*
naphthalose and *oxide of chloroxenaphtose*. Alcoholic solution of p
converts it into chloroxynaphthalate of potash, and from this
chloroxynaphthalic acid ($C_{20}H_5ClO_6$) is easily isolated. *Chlori*
perchloroxynaphthyl ($C_{20}Cl_6O_4$) obtained by the action of nitric acid
sexchlornaphthalin is converted by alcoholic potash into perc
oxynaphthalate of potash, and from this salt the *perchloroxynaph*
acid or *chloroxynaphthalesic* acid ($C_{20}HCl_5O_6$) is easily isolated.

NAPHTHALIDAM. [Naphthalic Group.]

NAPHTHALIDINE. [Naphthalic Group.]

NAPHTHALIMIDE. [Naphthalic Group.]

NAPHTHALIN. [Naphthalic Group.]

NAPHTHAMEIN. [Naphthalic Group.]

NAPHTHASE. [Naphthalic Group.]

NAPHTHENE. [Naphtha.]

NAPHTHÉINE. A name, given by MM. Jaubert de Beaulie
Desvaux, to a mineral found in the department of the Maine-et-L
France. It much resembles the elastic bitumen found in the De
shire lead mines, and is probably only a variety of ozokerite. [Ozo
rite, in Nat. Hist. Div.]

NAPHTHIONIC ACID. [Naphthalic Group.]

NAPHTHOLE. [Naphtha.]

NAPHTHYL. [Naphthalic Group.]

NAPHTHYLAMINE. [Naphthalic Group.]

NAPHTHYLCARBAMIDE. [Naphthalic Group.]

NAPHTHYLDITHIONIC ACID. [Naphthalic Group.]

NAPHTHYLSULPHOCARBAMIDE. [Naphthalic Group.]

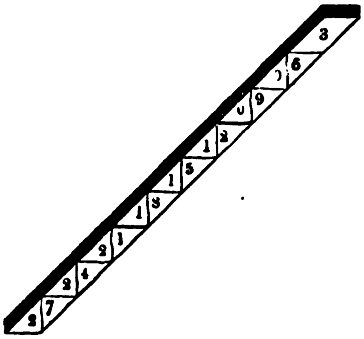
NAPHTHYL-SULPHUROUS ACID. [Naphthalic Group.]

NAPHTHYL-THIOSINNAMINE. [Mustard, oil of.]

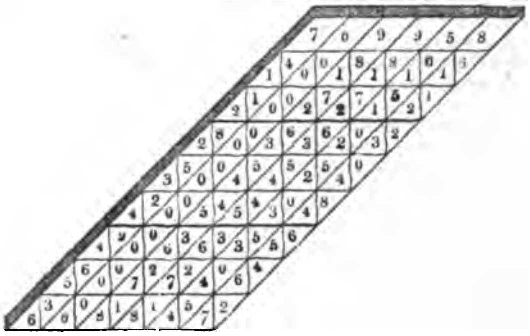
NAPHTHYLUREA. [Naphthalic Group.]

NAPIER'S BONES, or RODS, a contrivance of Napier to facil
the performance of multiplication and division, explained by hi
his 'Rabdologiæ, seu numerationis per virgulas libri duo,' Edinbu
1617, 12mo. The invention would have been perhaps more em

but for his discovery of logarithms; and even yet it might be used with advantage by young arithmeticians in verification of their work. We shall therefore describe it, with a very slight modification, which somewhat facilitates its use.



The preceding cut represents one of the rods belonging to the number 3. It is a parallelogram with an angle of 45°, containing nine equilateral parallelograms, with one vertical diagonal in each. In these are distributed, in a manner which will be visible at a glance, the multiples of the number which stands at the head, up to nine times. A sufficient number of rods must be provided for each of the headings 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, so that by placing the proper rods side by side, any number may be seen at the head, as in the following diagram, which represents rods in juxtaposition ready for the multiplication of 709958.



709958
32978

5679664
4969706
6389622
1419916
2129874

23412994924

If we wish to multiply by 32978, we look at the eighth column of multiples, in which we see the following disposition of figures (which, however, it is not necessary to write down afresh):—

602204
507746

Those may be added on the rods, and the result 5679664 written down in its proper place. The same is done with the other digits, and the results are added in the usual manner.

The only difference between the preceding description and Napier's rods is, that in the latter the rods are upright, and the additions that are made from the rods are therefore made diagonally. The compartments should be made large enough to allow of the figures which are to be added standing directly under one another. They represent a method on paper of the Hindoo arithmeticians, of which Napier knew nothing.

Napier's *bones*, as they were called, have been much more often described in historical works than in those intended for use. Sir Walter Scott must have had an indistinct remembrance of them, without however knowing what the phrase meant, when he made Davie Ramsay, in the 'Fortunes of Nigel,' swear by "the bones of the immortal Napier."

NAPLES YELLOW. A pigment used by artists. It consists of antimoniate of lead, and is produced by heating antimonic acid with oxide of lead.

NARCEINE. [OPIUM, ALKALOIDS OF.]

NARCETINE. [OPIUM, ALKALOIDS OF.]

NARCITIN. A non-azotised emetic substance found in the white narcissus.

NARCOGENINE. [OPIUM, ALKALOIDS OF.]

NARCOTICS (from the Greek adjective *ναρκωτικός*, which is from *ναρκή*, a stiffening, stupor, or insensibility), a class of medicines which may be defined—agents which, in moderate doses, cause a temporary increase of the action of the nervous and also of the vascular system, followed more or less speedily by a marked diminution of this action, terminating generally in sleep. When the dose is large, the excitement is scarcely perceptible; while the diminished power of the nervous system is so manifest, that an appearance of coma or apoplexy is induced. All the agents included in this class are capable of producing a state termed narcosis, or narcotism, which, if not quickly removed by a natural subsiding of their influence, or by artificial means, may terminate in death. Many of them are therefore as familiarly known as poisons as therapeutic agents. It is the consideration of them however in this latter quality which is to be entered on in this place. Their power of inducing sleep has procured for them the name of hypnotics, or soporifics; and the property which many of them possess of alleviating pain, by blunting the sensibility, has obtained for them the appellation of anodynes [ANODYNES], or, from one of the best known among them, simply opiates.

The most important consideration respecting them is the circumstance of their depressing action being always preceded by a stimulant. This peculiarity renders their employment difficult in some cases and improper in others. "Narcotics must be distinguished from stimulants on the one hand, and from sedatives on the other; and the distinction is the more necessary, because in nature the narcotic principle is generally combined with one or other of these: hence the contradictory and unsatisfactory reports of the value of different narcotic remedies, and the difficulty experienced in their application by those who do not know the reason why opium suits one case, hyoscyamus another." (Billing's 'First Principles of Medicine,' 3rd edit.) The progress of chemistry, by isolating the various active principles existing in the same natural compound, has lessened the difficulty attendant on their administration; still, as no one can be said to act in a manner precisely similar to another, a correct knowledge of each is desirable in order to ensure the selection of that which is best suited to the case. Diversified as they are in their nature and modes of action, there is this common property, that they all make a direct impression on the extremities of the nerves (to whatever part of the body, with few exceptions, they are applied); but their full and ultimate effects do not take place till they are absorbed, and mingled with the circulating fluid.

A slight glance at their action on the different systems of the body will furnish a useful guide in their administration. A full dose of a narcotic introduced into the stomach will, if that organ be empty, destroy the desire for food, while, if it contain food, the digestive process is suspended or rendered slower. Their frequent or continued use is therefore very injurious to that function, on which all the others depend, namely, nutrition; as is displayed in the persons of opium-eaters of the East. Further, should any considerable irritation or subacute inflammatory condition of the mucous coat of the stomach exist, they cause an aggravation of the febrile symptoms, and either in common or cancerous ulceration of that organ they cause great uneasiness. Though their primary effect on the vascular system be stimulating, and many of them send thereby a large quantity of blood to the brain (probably the source of their soporific property), their secondary effect is depressing; and in this the respiratory organs participate. This is at once a source of utility and of danger, for by moderating the action of the heart and lungs, the respiration is rendered slower, an advantage in most inflammatory complaints; but when pushed too far, the blood is not sufficiently aërated, and partaking too much of the nature of venous blood, it does not prove a sufficient stimulus to the brain and other organs.

Their action upon the secreting system is not very uniform, nor are all writers agreed as to its nature. Opium generally checks most of the secretions, except that of the skin, and causes heat, thirst and constipation. Hyoscyamus rarely causes any of these states, but on the contrary is rather laxative, and aconite greatly increases the secretion of the bile and also of the skin. Many natural compounds have an acrid principle combined with the narcotic, and hence are termed *narcotico-acrids*, such as aconite, squil, colchicum, hellebore, &c.: these generally augment the mucous and other secretions, though they produce narcotism in excessive doses.

Lastly, some of them possess greater influence over one set of nerves than the other, and expend their energy on the nerves of motion, or of sensation, according to their nature.

No set of medicines have their action more modified by a variety of circumstances—such as the quantity given, or the frequency of repetition, also the force of habit, climate, or season, but above all by idiosyncrasy. Age also has an important share in determining the amount of action. Children do not in general bear them well, and therefore though they are very subject to convulsive and spasmodic diseases, other means should be employed, especially the removal of the source of irritation, when practicable. The various nostrums recommended for children generally contain some narcotic, and prove a fertile cause of the mortality of early life. [ANTISPASMODICS.] The administration of narcotics requires more knowledge and judgment than that of any other class of remedies, and should only be had recourse to under competent advice.

In case of over-dose or accidental poisoning, the following observations may be useful. The stomach being rendered insensible to the irritation of emetics, these are generally useless, and much valuable time is lost by administering them. Where better means cannot be had, sulphate of zinc (white vitriol) dissolved in water, or a table-spoonful of flour of mustard diffused through a pint of warm water, may be given, accompanied with pressure on the pit of the stomach, and at the same time tickling the throat with a feather. Neither ipecacuan nor tartar emetic should be used; the latter is particularly unfit. [BELLADONNA.] The stomach-pump is the surest means of emptying the stomach, and should be used as soon as possible. If the brain appear much oppressed, the countenance flushed, and the pulse full, *moderate* blood-letting will be serviceable, especially if artificial respiration be subsequently employed. When the water brought up by the stomach-pump is clear and devoid of any smell of the poison, which will prove that all the hurtful material has been evacuated, *then*, and *not till then*, vinegar may be given to the patient, who should also be kept moving about, and not suffered, if possible, to sink into a state of slumber. Coffee is a very useful beverage, and still more a drink made by boiling twelve ounces of vinegar, and pouring it immediately on three ounces of roasted and ground coffee, or by boiling the coffee in the vinegar, straining it, then adding half an ounce of sugar, and giving it in small quantities to the patient every quarter or half hour. This can be prepared while the stomach-pump is being used, and is one of the most efficacious means of counteracting the narcotic principle. Vinegar given while any of the poisonous substance is in the stomach only increases its deleterious property. [ANTIDOTES.] See Pereira's 'Materia Medica,' for the mode of action of the different narcotic substances, i., p. 200; and Christison 'On Poisons.' The vapours of several fluids, such as sulphuric æther, chloroform, amyline, &c., have been used to produce insensibility, particularly during surgical operations. These have been already treated of under ANÆSTHETICS.

NARCOTINE. [OPIUM, ALKALOIDS OF.]

NASAMO'NES (Νασαμῶνες), a barbarous and nomadic people in Libya, who dwelt on the coasts of the Greater Syrtis. According to Strabo they were bounded on the west by the Psylli, and extended westward as far as the Philænian Altars, which were at the southern extremity of the Greater Syrtis (xvii., p. 836, 838, Casaub.). Herodotus places them farther to the west, and states that they occupied the country of the Psylli (iv. 173). On the east they extended beyond the Syrtis, and were bounded by the Auschisæ, a small tribe, who dwelt to the west of the Cyrenaica (Herod., ii. 32; iv. 172). Inland they had dominion as far as the oasis of Augila, in the great desert of Barca, which is 180 miles south-east of Barca, and is at the present day one of the resting-places of the caravans which trade between Cairo and Fezzan. [AUGILA, in GEOG. DIV.] The Nasamones were accustomed to leave their cattle on the coast in the summer season, and go to Augila to gather dates (Herod., iv. 172). Pliny (v. 5) also places the Nasamones on the Syrtis, and says that they were anciently called Mesamones by the Greeks, because they were situated between two quicksands (μέσος ἄμμος); meaning perhaps the two Syrtes, which however is not the case. All these may have been true at various times, for they were a numerous and wandering race, pressed on one side by the Greeks of Cyrene, and on another by the Carthaginians. Their territory, at the time of its greatest extent, must have extended for 400 miles from east to west along the Mediterranean, inland as far as Psylli and Augila.

The Nasamones are described by Herodotus (iv. 172, 190) as a numerous nomadic people, who were cattle breeders, who had a community of wives, were accustomed to swear by the tombs of the bravest and justest of their ancestors, and pledged their faith by drinking out of the hands of one another, or by licking dust out of one another's hands, if they had no water; they are described by Lucan ('Phars.,' ix. 404) and Q. Curtius (iv. 7) as a barbarous tribe, who lived by the plunder of the vessels shipwrecked on their coast. Bruce, who was shipwrecked on this coast, found that the present inhabitants followed the same practice. (Rennell's 'Geography of Herodotus.')

The Nasamones were driven into the interior of the country by the Romans in the time of Domitian. (Dionys. 'Perieg.,' ed Hudson, iv. 208; Eusebii, 'Chron.,' Ol. ccxvi.; Joseph., 'Bell. Jud.' ii. 16, § 4.) Ptolemy places them as far inland as Augila.

Herodotus gives (ii. 32) an interesting account of an exploring expedition, undertaken by five young men of this country, who crossed the great Libyan desert, and, after traversing extensive marshes, came to a large river flowing from west to east, with crocodiles in it, which he considered to be the Nile, but which many commentators have supposed to be the Niger. [NIGER.]

NASCENT STATE. When an elementary or compound substance is liberated from some chemical combination in which it had previously existed; the element or substance so liberated is, at the moment when it is set free, said to be in the *nascent state*. In this condition it is, as a general rule, capable of exerting far more energetic affinities than it exhibits when brought into contact with other bodies after it has been set at liberty. Thus acetic acid may remain in a vessel filled with oxygen for centuries without undergoing any change, but if the acid be brought into contact with oxygen at the moment when the latter is liberated at the positive pole of a voltaic decomposition cell, it is instantly oxidised and converted into carbonic acid and methyl like manner free chlorine gas has no action upon gold, but it in attacks the metal when in the nascent state, that is when it is liber in contact with gold, from any of its compounds. Such an exalt of chemical affinity at the moment of separation is not peculi gases, it is also noticed in the case of liquids and even solids. cause of this phenomenon is involved in considerable obscurity; we however indebted to Professor Brodie for the only philos explanation of it which has been attempted, and to this the read referred ('Philosophical Transactions for 1850,' p. 759).

NASIREANS. [NAZARENES.]

NATIONAL ASSEMBLY, the name by which the States Ge (États Généraux) of France had been sometimes known, and was fully adopted under Louis XVI., when the three estates united. Among the earliest acts of the National Assembly were th lication of the 'Declaration of the Rights of the Man and the C a piece of absurd and incongruous declamation; and the prepar of a new constitution. In September, 1791, this was presented king for his sanction, which was accorded, and the assembly dis itself on the 30th of the same month. The first National Assem frequently termed 'l'Assemblé constituante,' from its having fr the constitution. The constitution lasted about twelve month was succeeded by the Republic.

NATIONAL DEBT. The National Debt consists of borrowed from individuals, under the authority of the legis the government, and the security for which is all the property country. The money so raised is not to be paid on demand, the interest thereon, but, from its being transferable, this occas inconvenience to the individual, because he can raise money sale of the amount of his holding, according to the estimated his security, and the value of money at the time he feels a nec for it.

The national debt, we may observe, consists principally in countries, as well as our own, of money raised as above stated, is called the Funded Debt; but in Great Britain there is Unfunded Debt, which consists of money raised by granting for life or term of years, and by Exchequer Bills, which are re from time to time. [EXCHEQUER BILLS.]

The richer a country becomes the greater is the security loan is consequently acquired on easier terms. By this pr borrowing, a country whose credit is unimpeached is, when diate want of money, enabled to raise the sum required witho loading the springs of its natural industry. A man who has money than he can advantageously employ in manufactures merce, or persons who have no facilities or faculties for so emp it, will be glad to accept 4 or 5 per cent. for funds that ca employed more profitably; while those who are able to make cent. by the addition of their own exertions, will not invest the in a government loan. The raising of money by loan, thus fu means of securely employing sums that might possibly oth remain unproductive, produce a glut of money, or be emplo unprofitable speculation. It is a power, however, that requires prudently used; for if loans are too frequently called for the have the same effect as exorbitant taxes in crippling the gener for the employment of industry, besides imposing a heavy posterity in the shape of interest. But we shall enter no farth the interminable questions of the advantages and disadvantage National Debt, as it has been adopted by almost every civilised but proceed to describe its use and progress amongst ourselves.

The contracting of the National Debt cannot be said to have before 1691. The kings of England had indeed been accustomed a remote date to borrow money upon emergencies, but on occasions the revenues of the crown were pawned for the am which was seldom beyond what could by that means be repaid few years. The earliest instance of this borrowing which we ha record was in the reign of Richard I., when money was want defray the expense of his crusade to the Holy Land. Loans made upon Exchequer tallies by the Jews; and the Jews got they could in the shape of usury. Loans were also raised upon ture and privy seal; and sometimes the capitalist would not lend he had the security of the king's jewels. There was a perpetual between borrower and lender—between force and fraud. In time four centuries loans to the crown ceased to be so much a pers affair, and the Parliament stepped in to give additional security confidence to lenders. But every such loan was of temporary du even when public securities bearing interest became negotiable in In 1672, when 1,328,000*l*. of revenue was pledged for the imme payment of loans to the goldsmiths or bankers, whose advances chiefly made by funds intrusted to their keeping, Charles II., somewhat straitened by an expensive Dutch war and a few mistresses, shut up the Exchequer, issuing a proclamation anno that the 1,328,000*l*. should be paid in a year. There was univ panic and much private ruin. The principal was never redeeme the king charged his hereditary revenue with payment of intere this sum, which interest was duly paid to 1684. Law-suits wer tuted by the creditors against the crown when this intere stopped. At length an Act of Parliament was passed in by which, after the year 1705, the creditors were to receive

3 per cent. upon the original amount, to be redeemed when- r the government should pay a moiety thereof. That moiety of),263l. is a part of the present funded debt. But even for some r years after the accession of William and Mary the borrowings of government were for short periods only. In January, 1693, an was passed which empowered the raising a loan of a million by way life annuities, at 10 per cent. till 1700, and afterwards, and during life of the last survivors of the public creditors, at 7 per cent. The st loan of a permanent character arose out of the chartering of the nk of England in 1694, when its capital of 1,200,000l. was lent to public at 8 per cent. interest. A power of repayment was reserved this occasion by the crown, but no corresponding right of demand- g payment existed on the part of the bank. Still the system of minable annuities was that adopted by the statesmen of that day as g as practicable.

This cautious proceeding could not be long continned. The pensiveness of the wars in which the nation was engaged at the end the 17th century made it necessary to incur debts beyond the means their prompt redemption, and at the peace of Ryswick, in 1697, the bt amounted to 21½ millions. During the next ten years, although country was again involved in a continental war, its amount was luced to little more than 16 millions, and the greatest efforts were de to raise money without imposing any lasting burden on the ople. These efforts indeed soon found their limit, and at the acces- n of George I. in 1714, the debt had accumulated to the amount of millions, an amount which excited great uneasiness and caused the ouse of Commons to declare itself under the necessity of making orts for its reduction. In 1717 the debt amounted to 48½ millions, d the annual charge in respect of the same to 3,117,296l. A great rt of this debt consisted of annuities granted for 99 years, the money tained for which had varied from 15 to 16 years' purchase.

In the year 1720 the South-Sea Act was passed, authorising the mpany to take in, by subscription or purchase, the redeemable debts the nation, the object being to reduce all the debts under one head account at one uniform rate of interest. In the accomplishment of is scheme the projectors only partially succeeded, while the disgrace- l frauds by which the proceedings of the company at that time were arked, led to a parliamentary investigation which caused the disgrace some of the ministers, the chancellor of the exchequer being pelled the House, and committed to the Tower for his share in the ot. It is not the least remarkable circumstance attending this heme that it was attempted at the same time with the equally mous Mississippi scheme, which, with a similar object, was projected France by John Law, under the sanction of the Regent Duke of rleans. [LAW, JOHN, in BIOG. DIV.]

In 1736 the public debt in England amounted to about 50 millions, it the annual charge had been reduced below two millions. At the ace of Aix-la-Chapelle, in 1748, the national debt exceeded 78 illions, but in the following year the public obtained some relief om the burden through the lowering of the rate of interest. Little se was done in the way of alleviation at this time, and at the break- g out of the Seven Years' War, in 1756, the debt still amounted to millions. A public writer of some repute, Mr. S. Hannay, says, at at date, "It has been a generally received notion among political ithmeticians, that we may increase our debt to 100,000,000l., but ey acknowledge that it must then cease by the debtor becoming nkrupt." Those who in more recent times have witnessed the ldition year after year to the debt of sums equal to more than the fference between its then amount and its declared limit, may smile this prediction, and learn to put little faith in opinions which are ot based upon previous experience.

When the Seven Years' War was ended by the peace of Paris, the ebt reached 139 millions, and the annual charge was 4,600,000l. uring the twelve following years, a period of profound peace, only 0,400,000l. of the debt was discharged. The war of the American ndependence raised the debt from 129 to 268 millions, and the annual harge in respect of the same to 9,512,232l. So little was done in the ay of liquidation during the following ten years, that at the begin- ing of the war of the French Revolution the debt still amounted to 60,000,000l., and its annual charge to 9,437,862l. The outlay occa- ioned by the prosecution of that war was great beyond all precedent. etween 1793 and the peace of Amiens the addition made to the apital of the debt amounted to 360 millions, and the annual burden as increased from 9,437,862l. to 19,945,624l. Between the recom- neneement of the war in 1803 and its termination after the battle of Vaterloo in 1815, there were added 420 millions to the capital of the ebt, which then amounted, including the unfunded debt, to 885 illions, and the annual charge upon the public exceeded 32 millions f money. This enormous, this frightful rate of progression, appears have excited far less alarm than was expressed at the comparatively rifling additions made at the beginning of the funding system, a con- equence which probably must be in great part attributed to the stablishment of the sinking fund, and to the hope which it held ut of cancelling at no very distant period each amount of debt suc- essively increased.

A plan for the gradual extinction of the National Debt by the stablishment of a sinking fund was proposed and partially applied in 716 by Sir R. Walpole. The scheme for that purpose proposed under the same name by Mr. Pitt in 1786 had a greater show of reality about it. By this scheme the sum of one million was annually set apart from the income of the country towards the extinction of its debt. Other sums were rendered accessory to the plan, and it was supposed that at the expiration of 28 years the annual income of the sinking fund would amount to four millions, a part of which might then be applied towards relieving the burden of the public. So far the project bore the stamp of reasonableness and prudence: had the fund of one million annually assigned to commissioners been an actual surplus of income over expenditure, its operation must speedily have been highly advantageous to the country. The fallacy consisted in this, that the sums devoted to it were borrowed for the purpose. The only real advantage secured by this means arose from the unfounded confidence which it imparted to the public, under which they willingly bore a higher rate of taxation than might have been tolerable but for the expectation of future relief through its means. Now that the absurdity is acknowledged of borrowing in order to pay off debt, which absurdity would in the case of an individual always have been apparent, it is difficult to account for the blindness with which the whole nation clung to this so-called fund as the certain means of extinguishing the debt which in effect it contributed to augment through the less advantageous terms upon which the money was borrowed than those upon which an equivalent amount of debt was afterwards redeemed. The difference between the average rates at which money was borrowed and at which purchases were made by the Commissioners who managed the sinking fund between 1793 and 1814 was such, that through the operations of the fund, upon which such confident hope of relief was placed, the country owed upwards of 11 millions more at the end of the war than it would have owed but for those operations. At the period just mentioned the annual income of the sinking fund amounted to 13,400,000l., arising from dividends on stock purchased by the commissioners with funds borrowed at a higher rate of interest for the purpose. It was impossible however during a time of peace to raise by means of taxes so large an amount, in addition to the actual current expenditure of the country and the interest upon the unredeemed portion of the debt. During the war, when the deficiency of income was covered by yearly loans, the fallacy was not quite so apparent as it now soon became, for a few years after the peace the deficiency in the public income was borrowed from the sinking fund commissioners by parliament, a course which served to render the absurdity only the more apparent, and in 1824 the plan of keeping up a large nominal sinking fund in the absence of actual surplus income was abandoned.

The amount of the National Debt unredeemed on the 5th of January, 1816, was stated to be as follows in the fourth Report of the select committee of the House of Commons on public income and expenditure:—

3 per cent. stock	£580,916,019
3½ "	10,740,013
4 "	75,725,504
5 "	148,980,403
Perpetual annuities	816,311,939
Terminable annuities, 1,894,612l., equal to an estimated capital of	30,080,347
Unfunded debt	38,794,038
Total of unredeemed debt	£885,186,324

The annual charge upon which was—

Interest upon perpetual annuities	£28,278,919
Terminable annuities	1,894,612
Interest on unfunded debt	1,998,937
Charge for management paid Bank of England	284,673
Total annual charge	£32,457,141

The experience of the last fifty years has proved that the only important relief from the pressure of debt to be obtained, even during a profound and long-continued peace, will probably be derived from the lowering of the rate of interest. The price of 5 per cent. stock at the beginning of 1822 was advanced to 6 or 8 per cent. above par, and advantage was taken of this circumstance to induce the holders to exchange each 100l. of 5 per cent. annuities for 105l. of 4 per cent. annuities. On this occasion 140,250,828l. of 5 per cent. stock was cancelled, and 147,263,328l. of 4 per cent. stock was created, the annual charge being by this means reduced by the sum of 1,122,000l. In 1824 a further saving of 381,034l. per annum was effected by reducing to 3½ per cent. the interest payable on 76,206,822l. of 4 per cent. stock; and in 1830 a further abatement of one-half per cent. was effected on the 4 per cent stock created in 1822, whereby the sum of 700,000l. per annum was saved to the public.

Some progress was made after 1816 in the reduction of debt by the employment for that purpose of actual surplus revenue. An addition on the other hand was made to the public burdens by means of the grant of 20,000,000l. voted by parliament for compensation to the owners of slaves in the British colonies who were emancipated by the act of 1833. Down to the commencement of the war in the Crimea in 1854, a reduction greater or less had taken place every year, but that war occasioned an expenditure that created a loan for 20,000,000*l.*; and the suppression of the rebellion in India, though the loan occasioned by that war was charged on the Indian revenue, has prevented any further diminution. The unredeemed funded and unfunded debt which existed on March 31, 1857, and the annual charge thereon, were as follows:—

	Rate of Interest.	Amount. £	Annual Interest. £
New annuities . . .	2½	2,993,331	74,833
Consolidated annuities . .	3	395,068,382	11,852,051
Reduced annuities . . .	3	113,817,476	3,393,524
New annuities	3	213,143,113	6,394,293
Debt to Bank of England .	3	11,015,100	330,453
New annuities	3½	240,746	8,426
" . . .	5	431,124	21,556
Total permanent debt .		£736,009,272	£22,075,136

The unfunded terminable annuities were—

		Amount.	Annual Interest.
For life		9,984,253	1,030,856
For terms of years		2,710,125	867,490
Long annuities (expired 1860) .		3,008,922	1,156,744
Annuities (expire 1867) . . .		4,906,417	585,740
" (expire 1885) . .		2,059,810	116,000
Tontine and Exchequer life annuities. English .		161,748	15,639
Tontine and Exchequer life annuities. Irish .		195,766	26,084
Exchequer bonds . . .	2¾	418,300	11,503
Total terminable debt .		£23,445,341	£3,810,056

The Irish permanent debt was 43,692,145*l.*; the terminable debt 517,200*l.*, and the total amount of interest payable was 1,526,793*l.* The total funded debt of the United Kingdom was 779,701,417*l.*, the unfunded debt, 24,032,541*l.* In 1859 the funded debt had increased to 805,078,554*l.*, and the interest to 28,204,299*l.*

The diminution of the annual burden in the course of twenty-three years, from 1816 to 1839, was 3,150,710*l.*, at which rate the total extinction of the debt would not have been effected until the year 2053. The slow progress made in this direction stands in striking contrast to the rapidity with which the load was accumulated, the entire diminution effected during twenty-three years of peace being scarcely equal to the additions made during some of the individual years of the war.

In comparison with the debt entailed upon the British na previous wars, the war of the French revolution, costing, in a to a vast amount of current taxation, a permanent debt of six h millions, may be regarded, in its pecuniary sacrifices, the m contest in which a great nation was ever engaged; but if cons a struggle for national existence, the cost may be thought n portionate to the object gained. Of the necessity for that w are very opposite views, into a discussion of which it is n business here to enter.

From 1816 to 1854, thirty-eight years of peace had red capital of the debt seventy-seven millions. Two years of war b up thirty-eight millions; again to be slightly reduced when t but expensive contest with Russia was at an end. The vast inc capital and population since the beginning of the century m interest of the debt, enormous as it is, fall lighter upon ind. Roughly estimated, the debt of 1801, whose interest am twenty millions, was a burden of 2*l.* per head upon each of the lation of Great Britain. In 1860, the debt, whose interest am twenty-eight millions, is a burden upon each of the British p of 1*l.* 4*s.* per head.

We have constructed a table, out of the official abstract, wh demonstrate, beyond the possibility of cavil, that the vast n debt of this country has been created by its wars. It is not f argue for or against the necessity for those wars. It may be a that they could not have been carried on by laying the load of ta upon the existing tax-payers, at their commencement, or dur continuance; but it is equally certain that the power of b posterity may be a very dangerous power, liable to plunge a into unjust and unnecessary quarrels; and, carried to excess, i a perpetual load upon every exercise of productive industry demands upon that industry to repair the natural consum quired for the ordinary wants of man is unceasing. Pr however large, can with difficulty keep pace with the extra waste of war. The war expenditure from 1793 to 1815 was enormous a scale, that the total amount paid and expended year had risen from 19,859,123*l.* in 1792, to 92,280,180*l.* in 181 about 35 millions extra in the two years of 1813 and 1814. W the facility of borrowing, this vast amount could not hav raised. Whatever may be our political views, we may th unite in the conclusion that a national debt may be a good s in times of extreme need, but a bad master if its aid be ha invoked.

Period.	Debt.	Interest.	Years of War.	Increase of Debt in Years of War.	Remarks.
	£	£		£	
1691	3,130,000	332,000			
1701	12,552,486	1,219,147	1691—1697	11,892,925	French War.
1714	36,175,460	3,063,135	1702—1713	21,932,622	War of the Succession.
1748	75,812,132	3,165,765	1718—1721 1740—1748	14,025,424 22,531,551	Continental Wars.
1763	132,716,049	5,032,733	1756—1763	58,141,024	Pitt's Administration.
1792	239,663,421	9,432,179	1774—1783	104,681,213	American War.
1815	861.039,049	32,645,618	1793—1815	621,375,628	War of French Revolution and against Napoleon.
1859	805,078,554	28,204,299	1854—1856	32,793,308	War with Russia.
				£886,873,690	From 1691 to 1859.
Amount of National Debt 1859				805,078,554	Years of War 82
Decrease in Years of Peace				£81,795,136	Years of Peace 86

It will be seen, on comparing the above statements for 1815 and 1857, that the terminable annuities have increased from 1,894,612*l.* to 3,810,623*l.*, equal to an estimated capital of 23,445,341*l.* A part of the terminable annuities expired in 1860, and after that time other portions will fall in; so that without looking to any redemption of debt from surplus income, or to any further reductions in the rate of interest, the next twenty-eight years will be productive of still further relief.

The functions intrusted to the Bank of England with reference to the National Debt do not extend to the transaction of any matter connected with its reduction. Such business is placed under the control of a body of commissioners, who act *ex officio* under the provisions of an act of parliament. This board is composed of the speaker of the House of Commons, the Chancellor of the Exchequer, the accountant-general of the Court of Chancery, and the governor and deputy-governor of the Bank of England. The greater part of these commissioners do not take any part in the management of the business, the details of which are attended to by permanent officers, namely, a secretary and comptroller-general, and an actuary, with an adequate establishment of assistants and clerks: the ultimate control is exercised by the chancellor of the exchequer for the time being, assisted by the governor and deputy-governor of the Bank of England.

NATIONAL GALLERY. The credit of founding a National Gallery of paintings is due to the government of Lord Liverpool. Often as the importance of such a gallery had beeen urged, it was not till 1828 that the intention was seriously entertained by the government. The subject was in that year first formally brought be parliament by the Hon. George Agar Ellis, afterwards Lord Dove the merit of the suggestion is ascribed to the king, George IV. It announced that Sir George Beaumont, one of the most influenti patrons of the day, was willing to present the more valuable portio his own collection to the nation as soon as it should be decide commence the formation of a national gallery; that a favourable o tunity offered for the purchasing another choice collection; and t the two would together form an excellent nucleus for a great p gallery. Parliament approving, Mr. Angerstein's collection was p chased for 57,000*l.*, and the purchase, with the addition of 3,0 the expenses of the establishment, was sanctioned by the usual v April 1824.

By a Treasury Minute of the following July, a committee o trustees was appointed the superintending body over the gallery; active management being intrusted to a keeper, under whom was assistant keeper and secretary; and this, with slight modification c tinued to be the arrangement until the reconstitution of the galle 1855.

The Angerstein collection was opened to public inspection at M Angerstein's house in Pall Mall on the 10th of May, 1824. Sir Ge Beaumont's pictures were not added till somewhat more than a later. The Angerstein collection consisted of 38 pictures, of whi were by the old masters, and 9 by British painters. The purchase in every respect an admirable one. Most of the pictures were o high class, unquestionably authentic, and of a kind to secure the pu nterest and admiration. At the head of them was the masterpiece of Sebastian del Piombo, one of the pictures placed by common consent among the very finest works of the best age of painting; and one in which is recognised a combination of the art of the painter whose name t bears, and of the greater hand of Michelangelo. By Sebastian's rival, Raffaelle, there was the noble portrait of Julius II. Of Titian, Correggio, and the Carracci, there were also examples, though of inferior value. The painters of the Low Countries were well represented by the 'Rape of the Sabine Women,' by Rubens; by Rembrandt's 'Woman taken in Adultery,' and 'Adoration of the Shepherds;' and by Vandyck's 'St. Ambrose and the Emperor Theodosius;' while of the Italo-French school there were a very characteristic 'Bacchanalian Scene,' by Nicolas Poussin; a couple of landscapes by Gaspar Poussin; and no ess than four landscapes by the prince of landscape-painters, Claude Lorraine, two of them being of large size and great excellence. The nine English pictures consisted of Hogarth's inimitable portrait of himself, and his admirable series entitled 'Marriage à la Mode;' Reynolds's masculine portrait of Lord Heathfield, the Defender of Gibraltar; and Wilkie's brilliant 'Village Festival.' The gift of Sir George Beaumont was a worthy pendant to the Angerstein purchase. It consisted of sixteen pictures, of cabinet size, but for the most part of excellent quality. Himself a zealous (amateur) landscape painter, it was, as might be expected, in landscape that the Beaumont collection was richest, there being in it four small landscapes by Claude, one at least of surpassing beauty; others by N. Poussin; by Both (a capital example of his manner); by Rubens (the famous Balbi landscape, and, unlike most of Sir George Beaumont's pictures, of large size); by Canaletto; and by our own Wilson—the 'Niobe,' and the 'Villa of Mæcenas.' Among the other works was Wilkie's 'Blind Fiddler.' About the same time the British Institution presented to the nation the 'St. Nicholas,' of Paolo Veronese; the 'Vision of St. Jerome,' by Parmigiano; and West's 'Healing the Sick.' Mr. Zachary added a 'Spanish Boy,' by Murillo; and the Rev. W. Long the 'Banished Lord' of Sir Joshua Reynolds; whilst the government purchased for 3,800*l.*, a 'Holy Family,' by Correggio; and for 9,000*l.*, a 'Bacchanalian Dance,' by N. Poussin; 'Christ appearing to Peter,' by Annibale Carracci; and Titian's fine joyous 'Bacchus and Ariadne.'

Thus, then, the National Gallery was fairly launched. Its progress, however, was for a time very slow. Had it not been for bequests and presentations, it would not, indeed, have made any progress at all, no picture of any kind having been purchased between 1826 and 1834, when the Marquis of Londonderry's two superb Correggios (the 'Ecce Homo,' and 'Mercury instructing Cupid,') were bought for 11,500*l.* Before this, however, three or four valuable English pictures had been presented to the gallery (including the 'Holy Family,' of Reynolds, and the 'Market Cart,' of Gainsborough, the gift of the British Institution). Another fine work was Rubens' splendid 'Peace and War,' the gift of the Marquis of Stafford. But the most important addition was the noble bequest of the Rev. W. Holwell Carr in 1831, of no less than 35 pictures, all but one by the old masters, some of them being of a high class. For the next ten or twelve years bequests fell in rather rapidly, perhaps owing somewhat to the interest aroused by the building of the new National Gallery, which was commenced in 1832, and opened to the public in 1838. In 1837 the collection received an augmentation of 17 pictures, bequeathed by Lieut.-Colonel Ollney, mostly of small size, but of a class attractive to ordinary visitors; in 1838 it received 15 pictures, chiefly of the Dutch and Flemish schools, left by Lord Farnborough; and in 1846, 14 left by Mr. R. Simmons. The chief subsequent bequests, besides the two landscapes by Turner, left on condition that they should be placed in juxtaposition with two of the finest Claudes in the gallery, and the magnificent series of pictures, drawings, and sketches, which the great painter desired should form a separate collection, have been eight pictures bequeathed by Lord Colborne in 1854; three (a Giorgione, a Titian, and a Guido) bequeathed by the poet Rogers in 1857; and nineteen modern pictures bequeathed by Mr. Jacob Bell. The presentations during the same period have been chiefly of single pictures, and few of them have been of any remarkable value, with the exception of the collection of one hundred and fifty-seven pictures by English painters, the munificent gift of Mr. Robert Vernon.

Whilst, however, the vast importance of these bequests and gifts is fully acknowledged, it must be felt that it is upon the purchases that such an institution must mainly depend for the maintenance of a character worthy of the nation. Up to the time to which we have traced the purchases it will have been noticed that they were irregular, fitful, unsystematic. The principle adopted, as far as any principle was adopted, seems to have been to purchase any obtainable good paintings by the great masters of the best periods of the art in Italy and the Netherlands,—if the prices were not too high, and there were any money available for the purpose. Thus in 1837 three pictures were purchased for 9030*l.* (the 'Holy Family,' of Murillo; the 'Brazen Serpent,' of Rubens; and the 'Mercury and the Woodman,' of Salvator Rosa); in 1838, none; in 1839, for 7350*l.* three (one of them being the exquisite 'St. Catharine,' of Raffaelle; the others, 'Holy Families,' by Garofalo and Mazzolini); in 1840, two; in 1841, three for 4300*l.* (two by Francia, and one by Pietro Perugino): in 1842 and 1843, one each ('Portraits,' by John Van Eyck of himself and wife (630*l.*), and an 'Apotheosis,' by Rubens); in 1844, six (including Rubens's 'Judgment of Paris,' for which 4200*l.* was paid); in 1845, two; in 1846, two (one of them the 'Boar Hunt,' by Velazquez, for 2200*l.*); and in 1847, one (Raffaelle's beautiful little allegory, 'The Vision of a Knight,' which was obtained for 1050*l.*). There then occurred an interval of three years without a purchase, partly owing, no doubt, to the disturbed state of political affairs during at least a portion of the period, but also to the discussions which had arisen respecting the general management of the gallery. In 1851 two pictures were bought (a 'Portrait of Rembrandt,' by himself, for 430*l.*, and a 'Portrait of a Man,' by Vandyck, for 365*l*). In 1852, the only picture purchased was Titian's 'Tribute Money,' at a cost of 2604*l.* In 1853 two Spanish pictures were purchased from the collection of Louis Philippe—a 'Franciscan Monk,' by Zurbaran, for 265*l.*; and 'The Adoration of the Shepherds,' by Velasquez, for 2050*l.*; together with an 'Infant Christ,' of the school of Bellini, bought of Mr. Woodward for 500 guineas.

Up to this time the pictures purchased had continued to be almost exclusively such works of the painters commonly spoken of as the great masters, as were brought under the notice of the Trustees, and deemed by them suitable for the gallery. But in 1853 a new system was inaugurated. The inquiries instituted by the Commissioners of the Fine Arts, and the growing interest taken in all matters connected with early art, called forth a strong feeling in favour of the formation of a collection of early pictures, and the re-arrangement of the National Gallery on a chronological and historical basis. This view was adopted by a Select Committee of the House of Commons on the National Gallery, 1853, who embodied their views in a Report, the concluding passage of which recommended that "the funds appropriated to the enlargement of the collection should be expended with a view, not merely of exhibiting to the public beautiful works of art, but of instructing the public in the history of that art, and of the age in which, and the men by whom, these works were produced."

Effect was at once, to a certain extent, given to these views by the purchase, in 1854, of the collection of 64 early German works (but of which only 17 were retained for the Gallery, 10 being sent to the Dublin Gallery, and 37 sold by auction) belonging to Herr Krüger of Minden, and of some specimens of San Severino. Filippo Lippi, and other early Italian masters. But it was formally "embodied, leaving a due latitude to the trustees and directors, in the Treasury Minute dated 27th March, 1855, reconstituting the establishment of the National Gallery." (Report, 1858.)

By this reconstitution, whilst the Trustees were retained as the nominal superintending body, a superior salaried officer was appointed under the title of Director, to whom the selection and purchase of pictures for the gallery were intrusted, and on whom, in the words of the minute, was fixed "the final responsibility in all cases in which any difference of opinion may exist." Another new office created by the Treasury Minute was that of Secretary and Keeper, who was to rank immediately under the director, and to reside in the building as custodian of the pictures. The third office created was that of "Travelling Agent," who was to be a sort of assistant to the director in searching out among the pictures offered for sale on the Continent such as were suitable for the National Gallery. No material change was made in the inferior officers: instead of an occasional grant, there was to be inserted annually in the estimates for the National Gallery "a sum expressly for the purchase of pictures."

To the office of director was attached a salary of 1000*l.* a year. The gentleman appointed to that very important post—one on which the future rank and character of the gallery must mainly depend—was Sir Charles Lock Eastlake, the President of the Royal Academy, distinguished alike as an artist and as a writer on art. To the office of keeper and secretary—an office more laborious probably, and scarcely less onerous than that of director—a salary of 750*l.* a year was attached, and the government was fortunate in securing for the post the services of Mr. R. N. Wornum, a gentleman well known as a writer on the history of painting, and the lives of painters, and possessed of an unusually extensive acquaintance with pictures and with art-literature. Both these gentlemen have continued to hold their appointments to the present time. The travelling agent was to have a salary of 300*l.* a year, and an additional allowance for travelling expenses while absent on his professional duties on the Continent. To this office Herr Otto Mündler, a gentleman minutely acquainted with picture-galleries and old pictures, was appointed: the office was however abolished, in consequence of a vote of the House of Commons in 1858.

Under this new constitution the National Gallery made a very remarkable advance: not only were fresh pictures sought out and purchased, but the pictures already possessed were carefully examined, some covered with glass, others cleaned, or measures taken for their preservation, while of the state of all a most careful register was drawn up: the whole institution, in fact, was put into better working order, and subjected to a more searching and constant supervision.

The pictures purchased under the new régime have been of a very important character. In 1855 and 1856 twenty-six pictures were bought, but among these, and forming parts of collections, were seven which were not placed in the National Gallery; five being deposited in the National Gallery of Ireland, and two sold at Christie's with the Krüger pictures, under authority of an Act of Parliament (passed in June, 1856) which empowered the trustees and directors "to dispose of such works as may have been purchased or bequeathed, but should be considered unfit or not required for a national collection;" thus enabling the authorities to deal for the purchase of collections of pictures with much more freedom than hitherto. Among the works retained, two were by Botticelli; one by Mantegna; one, an altar-piece grandly painted, and of very large size, by Paolo Veronese; one a 'Virgin adoring the Infant Christ,' a masterpiece of Pietro Perugino, obtained for 3571*l.*; the rest were chiefly by early Italian masters. But the new system was seen in its full flow in 1857, when no fewer than forty pictures were added to the collection by purchase. Of these the Lombardi-Baldi collection of early Italian (chiefly Tuscan) masters, comprised thirty-one pictures, and was obtained for 7035*l.* Other purchases were two pictures by Quintin Matsys, and one each by Lucas Cranach, John Van Eyck, Girolamo Romanino (an altar-piece in five compartments), and Borgognone; a Virgin and Child by Ghirlandajo, and the master work of Antonio Pollajuolo (for which the sum of 3571*l.* was paid)—all, therefore, early works, and especially valuable as illustrative of the historical progress of painting. But there was one picture purchased this year, the value of which was wholly different. This was the large and magnificent painting of the 'Family of Darius at the Feet of Alexander,' by Paolo Veronese, one of the most famous works of this great master, and, indeed, one of the most famous pictures in existence. It was purchased of the Count Pisani, for an ancestor of whom it was painted, and in whose family it had remained to the time of its purchase. Its cost was 13,650*l.*, a very large sum for a single picture; but it must be remembered that works of such a character are becoming constantly more difficult to procure, and consequently when any one is offered for sale, the agents of the various royal and national collections are eager competitors for its purchase, and the price is proportionately raised. Be the price as it may, this is unquestionably the most important single picture added to the gallery since its formation; and this, and the other pictures bought since the reconstitution of the gallery, are evidence of the advantages likely to accrue from a systematic search for works of a suitable character, rather than patiently waiting for them to offer themselves for approval.

During 1858, only eight pictures were bought, not exclusively, but still chiefly early works, the most important being a 'Deposition in the Tomb' by Marco Palmezzano, a 'Virgin and Christ' by Cima da Conegliano, another by Marco Basaiti, and portraits by Antony Moro and Moretto. In 1859 the purchases of the early masters were comparatively few. Eight pictures were bought in all: among them being a 'Pieta,' by Carlo Crevelli; a 'Madonna and Child Enthroned,' by Treviso, and another by Lorenzo Costa; a pair of 'Landscapes with Waterfalls,' by Ruysdael (cost 2250*l.*); and 'The Infancy of Jupiter,' by Giulio Romano (cost 920*l.*). In 1860 was purchased, at a cost of 9205*l.*, the entire collection of M. Beaucousin, of Paris, consisting of 46 pictures, of which 35 were retained for the National Gallery, including small specimens by Ghirlandajo, Titian, Giulio Romano, Lorenzo di Credi, Bronzino, Roger Van der Weyden, and other noted masters of various schools—none of them works of the highest order, but several very desirable examples of the respective masters.

Thus after an existence of thirty-six years the National Gallery, exclusive of the Vernon and the Turner collections, comprises 420 pictures; of which 203 have been purchased at a cost of 184,500*l.* (in which however is included the 22 pictures placed in the Dublin National Gallery), and 217 presented or bequeathed. Of these 350 belong to foreign schools, and 70 are by British artists. The latter have been, for the most part, donations, and are hardly looked upon as belonging to the National Gallery, which by the trustees has always been regarded as specially devoted to the works of the old masters. The building known as the National Gallery is indeed entirely appropriated to the foreign schools; the British paintings, after having been for some years hung in Marlborough House, being now all removed—with the exception of the two landscapes by Turner, which, by the terms of the bequest, must be placed alongside two of the Claudes—to a building constructed for their reception contiguous to the South Kensington Museum.

In extent the national collection is far inferior to several of the other national collections of Europe, and even to some of the private collections in our own country. Mr. Wornum has, in his admirable official 'Catalogue of the National Gallery,' given from their respective catalogues the numbers of several of these collections. It will suffice to mention, for the sake of comparison, that in the Louvre there are upwards of 1800 paintings, of which 543 are Italian; the Dresden Gallery has 2000; the Museo of the Prado at Madrid, 1833; the Berlin Gallery contains about 1350; in the Belvedere at Vienna there are upwards of 1300; in the Imperial Gallery of Florence upwards of 1200; and in the new Pinacothek, Munich, about 1270. To the number in the Louvre might also be added the 3000 paintings at Versailles (to say nothing of those in the Luxembourg), all by native artists, and illustrative of events in the national history; as, on the other hand, to exhibit the extent of our own pictorial wealth, we might add to the National Gallery pictures, those in the Vernon, Turner, and Sheepshanks collections, numbering in all 490 paintings by British artists. If these collections were brought together, the National Gallery would comprise upwards of 900 pictures: or without the Sheepshanks collection, which perhaps cannot be reckoned a part of the National Gallery, it would number 670 pictures.

But looking at our National Gallery as a collection of painting the old masters, we may, whilst admitting its inferiority to the continental galleries, regard its actual state with some complace consideration being had to the period of its formation, and subsequent political and other circumstances which have interfe with its development. Taking the "Tabular View of the Sch Painting as represented by the Pictures in the National Gallery" in official catalogue as our guide, we find that although many of the eminent painters of the several schools are unrepresented, or rep sented very inadequately, there are examples of the art, and for most part, of the best period, of almost every school. Thus, adopt the classification of the 'Tabular View,' we find that there are of Tuscan or Florentine school 57 examples; of the Umbrian, 6; of Romagna 1; of the Roman, 17; of the Venetian, 50; of the Pa 8; Bolognese, 34; Ferrarese, 9; Parmese (Lombard), 7; Crem (Lombard), 1; Milanese (Lombard), 1; Neapolitan, 3; Greek Byzantine, 1; Flemish, 35; Dutch, 44; German, 21; Spanish, 6; French, 34.

As we have said, it was to the pictures of what is by com consent regarded as the best period of each school that the purch of the trustees were until recently almost exclusively confined. B since the importance of obtaining works of the earlier and imma periods of the several schools has been recognised, very rapid prog has, as we have seen, been made towards supplying the deficien And important as this chronological view of art unquestionably is may perhaps doubt whether any attempt to carry it into operati an earlier date would have been altogether advantageous, or whe it may not even now be carried too far. The public required to have its interest in art aroused by means of pictures of unquestionable merit that no one could gainsay their value, and kind which, by appealing to the common feelings and understand mankind, would require no special archæological training to un stand and to appreciate. In truth, there is already something bewildering to the common mind in the present almost heterog admixture of the noblest works of art, at its highest stage of dev ment and independence, with those produced when art was the instrument of the ecclesiastic, and artists, themselves as yet feeling their way even to the technics of their pursuit, were hamp by archaic forms, conventionalities, and clerical symbolism precedent. Such works can have little interest for the uninstruct visitor, and assuredly they can do little to refine his taste or elev his thoughts. No lover of art will however object to the purchas such works; but on the contrary, be most anxious that they shou purchased, their true value being clearly recognised. It is said in Report for 1858 of the Director of the gallery in reference to purchase of the Lombardi-Baldi pictures, that "the unsightly sp mens of Margaritone and the earliest Tuscan painters, were sele solely for their historical importance, and as showing the beginnings from which, through nearly two centuries and a h Italian art slowly advanced to the period of Raphael and his temporaries." And this is precisely the reason for desiring pictures of every other important school. But there should be exclusive or even preferential regard given to these works. Let th be bought for their archæological value, but let the really great of art be at least as anxiously sought for. Beauty is too rare and precious a thing to be set aside for the sake of the "unsig antiquities whose chief charm is their age and their ugliness. An is further of the first importance that, in exhibiting these early to the public, this "historical" purpose should be distinctly pr out, or we may only increase the confusion in uninstructed minds to the true purpose of art, and as to what is really admirable These very early works are not merely often unsightly, but they (to modern and Protestant eyes) not unseldom profane, and some gross. Their unsightliness, profanity, and grossness, are, of course no consequence to the historical inquirer and the art-student these are qualities not to be wholly overlooked in catering for great public. The chronological and the geographical arrangem all the works of this antiquarian character ought to be strictly m tained. The truly great works—those which are really works of art—should not be buried amidst the uncouth, unsightly ch decoration work of the pre-fine-art ages. A strictly chronologica geographical arrangement of *all* the works, however it might sat formal spirit of systematism, or accord with the fashionable me valism, would assuredly be very wearisome if not misleading to general public. The early works, in short, are for the hist student; the master-works for all.

Of course any chronological arrangement according to schoo impracticable in the present National Gallery. The building, wh was erected from the designs of Mr. W. Wilkins, R.A., was only co pleted in 1838, yet that portion of it appropriated to the na collection of pictures is already so crowded—though it contains the comparatively small collection of paintings by the old maste that many works are necessarily hung in the passages and vestib and space has only been found for the display of recent acquisit by means of screens placed in the centre of the great room. For British pictures, rooms have been provided at South Kensington no spare space is left in them for relieving the overcrowded Nat Gallery of any foreign works, nor consequently do they afford itable room for the reception of new purchases or presents. uccessive governments have however, pledged themselves to provide dequate accommodation for the national collections. To do this, arious schemes of a more or less official character, for altering and larging the existing building, have been projected by the director, ir Charles Eastlake; by Captain Fowkes, the designer of the galleries South Kensington; and on a more magnificent scale by the late Sir harles Barry. The only sufficient remedy if the present site be tained, would be the removal of the present most ungainly, inconenient, ill-lighted, and utterly inappropriate building, and the conruction in its place (the barracks, &c., at the rear being included in e site) of one of sufficient size to contain in two great divisions—oreign and English—all our national pictures, and to admit of their rrangement in a convenient and systematic manner. But a far better lan, if indeed it be not too late so to appropriate the site—incomarably more suitable for the pictures, and hardly at all less conenient to the public—would be the construction on the site of urlington House of a grand National Gallery; which,—from the lmost indefinite capability which the site affords for extension with he growth of the gallery,—might be at once designed, as such a allery ought to be, to include a systematic collection of English as ell as foreign pictures, and English as well as foreign sculpture, and lso afford room for a National Collection of Water Colour Paintings, nd the National Portrait Gallery: in a word, be a really comprehensive National Gallery of Art, worthy of the country. Of this here is little probability. It is, however, admitted by all that he time has arrived when some provision must be made for the rowth of the collections, and it is understood that the Government as decided to carry out a plan prepared by Mr. Pennethorne, for he extension of the present building, though only as a temporary xpedient.

Gallery of British Art: Vernon Collection.—As we have seen, there ere included in the Angerstein collection, which formed the basis of he National Gallery, seven paintings by Hogarth, one by Reynolds, nd one by Wilkie; and among the Beaumont pictures, five were by British painters. There was thus provided, at the very origin of the ational Gallery, the germ of a Gallery of British Art. It would seem hat one of the most obvious duties of the trustees would be to watch ver and cherish the growth of the native section of the institution, ith at least as much care as the foreign. But native art was esolutely discountenanced. It is a remarkable fact, that every addiional specimen of English art which the nation possesses has been btained by what may be called chance. Except the nine works which ere included in the Angerstein collection, purchased six-and-thirty ears ago, not a single English picture has, up to the present hour, een *purchased* for the national collection. Every one which the ation possesses has been either a gift or a bequest. Such a thing is probably unparalleled in any other country possessing a collection of pictures; but it arose from the entire control of our National Gallery being vested in gentlemen who regarded the Old Masters as the only legitimate representatives of painting. From the first they resolved that from the British National Gallery, British art must be excluded. Such works of Hogarth, Reynolds, Wilson, Gainsborough, and Wilkie, as were given or bequeathed they could not, of course, actually refuse to admit; but even to them they only accorded a contemptuous shelter. That any approach whatever has been made to a collection of works of British art is in no wise due to the trustees of the National Gallery, or to the British government, but solely to the patriotism and the benevolence of private individuals.

After having been in existence twenty-four years, the National Gallery possessed 44 British pictures, of which 35 were gifts. Of these several were common-place portraits. The ignorance, and the contemptuous indifference of foreigners respecting British art, has often been complained of; but how could foreigners be expected to take any pains to acquaint themselves with what was treated with such supreme neglect at home? If British art were worth anything, it might fairly be supposed that the nation would not keep it so carefully out of sight. The effect of a public collection of the works of the leading English painters in correcting the low opinions prevalent of British art was well shown in the Manchester Exhibition of 1857. The great French painter Ary Scheffer we are told, "was scarcely less astonished than enchanted with the spectacle which that collection afforded him. 'I had no conception,' said he, 'how rich the English school was! There have lived great painters among you; *that* is unquestionable! . . . The power of dealing with colour, especially, possessed by the English artists, fills me with admiration, &c.'" (Mrs. Grote's 'Life of Ary Scheffer,' p. 117). And what Scheffer felt was felt more or less by every one, native as well as foreigner, who visited that remarkable collection.

The first actual attempt to provide a permanent gallery of national art was made in 1847, when Mr. Robert Vernon presented to the country his collection of 157 pictures, all but two being by British painters. For the most part the pictures were of a cabinet size, of homely and familiar subjects, and by living or recently deceased painters; though among them were 3 small works by Reynolds, 4 each by Wilson and Gainsborough, and 1 by Romney. Of our more eminent masters of a later date, the Vernon gift included 6 specimens by Stothard; 5 by Wilkie (all of second-rate quality); 6 by Hilton; 9 by Callcott; no less than 11 by Etty; 4 by Turner; 1 by Constable; 2 by Collins; 4 by Mulready; 3 by Eastlake (including two of his best works—'Christ Lamenting over Jerusalem,' and the 'Escape of the Carrara Family'); 2 by Leslie ('Uncle Toby and Widow Wadman,' and 'Sancho and the Duchess,'); 4 by Stanfield; 2 by Roberts; 2 by Lee; 7 by Sir Edwin Landseer (including his large picture of 'Wellington at Waterloo,' 'High and Low Life,' 'Peace and War,' 'Highland Music,' &c.); 2 by Maclise (the 'Play Scene in Hamlet,' and 'Malvolio and the Countess'); 2 by Webster ('Going to School,' and the 'Dame's School,'); 2 by Newton; 3 by Lance; 2 by Ward; and others by Creswick, T. S. Cooper, Bonington, Müller, Danby, Linnell, Uwins, Herbert, &c. They were pictures purchased by a private gentleman of plain tastes, for the decoration of a private house of moderate size. They were, therefore, not works of a kind that would, either in respect of size, subject, or pretension, have been chosen for a public gallery; but strictly cabinet or parlour pictures—pictures for quiet home enjoyment. Their presentation to the nation was an afterthought. While, therefore, they may be taken as very fairly representing the popular phase of British art, they are not to be received as adequately representing the school in its highest efforts, or even what it has actually accomplished. But though not great works, the collection included specimens—and most of them very excellent specimens—of the major part of the more eminent painters of Mr. Vernon's day. In short, it was a very admirable private collection; and it formed, in truth, a noble gift—so noble a gift, indeed, that it ought to have stimulated the nation, or its rulers, vigorously to carry on and complete the formation of a gallery of native art, so large an addition having been made to the means already possessed for the accomplishment of that object. Nothing, however, was done even towards providing a suitable place for the reception of so munificent a gift. Mr. Vernon's donation took effect during his lifetime, and the pictures were in the first instance exhibited to the public in his house in Pall Mall. From thence they were removed to the vaults underneath the National Gallery; and in 1850 they were taken to Marlborough House, where they remained till 1859, when that building was required for the residence of the Prince of Wales. A brick building was then erected for their reception adjoining the South Kensington Museum, and opening into it. It comprises seven spacious and well-lighted rooms, in which are hung the whole of the British pictures belonging to the National Gallery. One addition only, but that a worthy one, has been made to the British pictures in the National Gallery, since the gift of Mr. Vernon. This was the bequest in 1859, already referred to, of 19 pictures by Mr. Jacob Bell. Among these pictures are seven by Sir Edwin Landseer—including some of his best works—'The Defeat of Comus,' 'Sleeping Bloodhound,' 'Dignity and Impudence,' 'Highland Dogs,' 'Shoeing,' 'The Maid and Magpie,'; Leslie's 'Uncle Toby and Widow Wadman'—being the third copy of this picture now possessed by the nation; Ward's 'James II. receiving news of the landing of the Prince of Orange;' three pictures by Charles Landseer; and one each by Etty, Lee, Cooper, Douglas, and G. O'Neill; also Frith's 'Derby Day' and Rosa Bonheur's 'Horse Fair,' though the last two, as well as one of Landseer's, are at present retained for engraving by the purchasers of the copyright.

The placing of these pictures at South Kensington is, however, only a temporary arrangement: suitable provision is to be made for the British pictures in "the new premises," which the government have undertaken to provide for the national collections. When that shall be done, we trust that so opportune an occasion will not be let pass without undertaking the formation of a Gallery of British Art worthy of the name. It is a mortifying fact, that the Collection of British Pictures at Manchester was the first and the only opportunity Englishmen have ever had of seeing at one view what the British school has done and is doing. That collection is dispersed, but the example remains. We have here, in the 70 pictures belonging to the National Gallery, and in the 150 of the Vernon collection, a good groundwork for a national collection. The Sheepshanks pictures were expressly given to assist in the formation of a gallery of native art, but the gift was hampered with a clause as to the locality, which may render it unsuitable for that purpose. If that could be got over, they would be of the greatest value, and they would render tolerably complete the series of recent works of their class. The century of Turner landscapes are a specialty, and will in any gallery occupy their own apartment. But together we have thus 560 paintings by British artists, some 520 of them having been presented to the nation for the express purpose of assisting in the formation of a British gallery. In a few years Sir Francis Chantrey's bequest of above 2000*l.* a-year for a like purpose will fall in. If such a gallery were really taken in hand with an evidently sincere desire of making it what it ought to be, there can be no doubt that other gifts and bequests would not be wanting. All that would be required of the authorities, in addition to a suitable building, would be to see that the great object was kept steadily in view of making a thoroughly comprehensive collection of characteristic works. To this end suitable early pictures, and pictures of a high class, should be sought out and purchased, and for the present, at least, purchases should be strictly confined to works which fairly illustrate the rise and progress of British art. And surely if it be desirable to secure "unsightly" early examples of the Italian and German schools "solely for their historical importance," it is at least as important to Englishmen, even in an historical point of view, that they should possess a systematised chronological collection of works of the British school, beginning at the very beginning, and including the very noblest of its productions.

Turner Pictures.—During many of the last years of his life, the cherished wish of our great landscape-painter was to bring together as many as possible of his best works as an offering to his country. For this purpose he not only refused to sell such of the pictures he then painted as he deemed most suited for a public gallery, and most illustrative of his style, but, whenever an opportunity presented itself, purchased such of his earlier paintings, having like fitness, as were offered for sale. At his death, in 1851, he bequeathed to the nation these works, together with all his drawings and sketches, on condition that within ten years suitable accommodation should be provided for them. This princely gift—for, estimated merely at the money value according to the almost fabulous prices his pictures and drawings were then producing, the gift might without exaggeration be termed princely—comprised the extraordinary quantity of over a hundred finished paintings in oil, many of them of very large size, some hundreds of finished water-colour drawings, and several thousand studies and sketches.

The oil paintings and some of the sketches are exhibited in the new rooms at South Kensington. Of their value as works of art, it would be superfluous if it were not out of place to speak here. Alone, they would suffice to give the British school of landscape the foremost rank in respect of extent of range, comprehensiveness of subject, and poetic conception along with close observation of nature. As illustrative of the genius of Turner, it is enough to say, that they were deliberately chosen by Turner himself as the works by which he wished his countrymen and the world to judge him. They range over almost the whole of his career, and exhibit almost every phase of his style, from the strictest and most literal representations, up to his most daring imaginations. If they needed to be supplemented by others, we have in the National Gallery, the Vernon, and the Sheepshanks collections, eleven more of his oil pictures. But they are sufficient in themselves. Of the works of no other English painter are we ever likely to have anything like so large or so wonderful a gallery, or one so remarkably illustrating the progress of the mind of a great artist. It is only to be regretted that the drawings are not to be exhibited to the public as well as the paintings. These drawings, which when received by the trustees were in a very crushed and disorderly condition, have been carefully examined and arranged, and 400 of the most highly finished of them framed, and 1200 more mounted by Mr. Ruskin, who voluntarily undertook that troublesome task. They are, with the exception of those exhibited at South Kensington, deposited in cabinets in one of the lower rooms of the National Gallery.

The Sheepshanks Pictures.—The noble example of Mr. Vernon was in 1857 nobly followed. On the 2nd of February of that year, Mr. Sheepshanks, by a deed of gift, presented to the nation his valuable collection of paintings and drawings. The object of the gift, as stated in the deed, was the foundation of a "collection of pictures and other works of art fully representing British art." The gift was made on certain conditions, the most important of which was that "a well-lighted and suitable gallery, to be called the 'National Gallery of British Art,' shall be at once erected by her Majesty's government, and be attached or near to the public buildings built or to be built for the Department of Science and Art on the estate purchased by her Majesty's Commissioners for the Exhibition of 1851, or the public parks or gardens at Kensington." The collection is thus precluded from being united with that of Mr. Vernon and with the British pictures belonging to the National Gallery, unless these should also be permanently removed to Kensington. But Mr. Sheepshanks, so far from wishing his pictures to be kept apart from others, has expressly provided that they are to "be deposited in such gallery with any other pictures or other works of art that may be subsequently placed there by other contributors, as it is not my desire that my collection of pictures and drawings shall be kept apart, or bear my name as such." Further, Mr. Sheepshanks stipulates that "none of the said pictures or drawings shall ever be sold or exchanged," and he has placed them entirely beyond the control of the trustees of the National Gallery. They are vested solely in that member of the government, for the time being, "charged with the promotion of art education now undertaken by the Department of Science and Art." Finally, if these "terms and conditions be not strictly adhered to," the pictures and drawings are to be transferred to the University of Cambridge, "and for ever after to form part of the Fitzwilliam Museum."

These conditions were fully acceded to by the government. A convenient and well-lighted brick building, and one admitting of easy extension, was erected adjoining the iron Museum of Ornamental Art at South Kensington, and opened to the public in June, 1857. The rooms in which the Vernon pictures are now hung adjoin these, and the two galleries open into each other. Like the Museum of Ornamental Art, these rooms are open to the public free on Monday, Tuesday, and Saturday during the day, and on Monday and Tuesday evenings; and on the other three days and Wednesday evening on the payment of sixpence—rather a curious arrangement in a national institution, and one that we may hope will not be followed when
the British and foreign pictures are re-united in the N
Gallery.

The collection of Mr. Sheepshanks, like that of Mr. Vern
formed for a private house, and consists therefore entirely of
sized pictures. Far more than the Vernon collection, howeve
characteristic of the taste of the founder. Mr. Sheepshanks evi
bought and commissioned pictures only in accordance with h
personal likings. Even more exclusively than Mr. Vernon's
consist of genre and landscape-paintings. The examples of h
or purely imaginative works are extremely few. But in its w
collection is an admirable one. It comprises no fewer than
paintings, ranging over a period of about 50 years, and embrac
choice examples of many of the most eminent painters of the ti

Especially is it rich in the works of Mulready and Leslie,
whose best pictures are here; but it is rich, also, in the wor
Landseer, Wilkie, Stothard, and Webster. Of Mulready th
no less than 34 examples, the earliest painted in 1806, the la
1848. Some of these are very small, and comparatively unimp
but among them are his famous 'Choosing the Wedding Gow
of the gems of British art; his very beautiful 'Sonnet,' and
Love;' the popular 'Giving a Bite,' the 'Fight Interrupted,' a
'Butt—Shooting a Cherry,' three of his most humorous work
most elaborate though not his most successful picture of 'The
Ages;' and his interesting 'Interior, with a Portrait of Mr. S
shanks.' By Leslie there are 24 paintings, the dated ones ext
from 1823 to 1845. The best of them are his illustrations to S
pere, Molière, and Sterne, of whom he gives always a genial,
suggestive reading, and one marked by a quiet refined humour:
be enough to name the 'Katherine and Petruchio,' 'The Dinner
from the Merry Wives of Windsor,' 'Queen Katherine and Pa
'Florizel and Perdita,' 'Autolycus,' 'Le Bourgeois Gentilhomme,
Femmes Savantes,' 'Le Malade Imaginaire,' and the popular re
of 'Uncle Toby and the Widow Wadman.' By Landseer the
16 paintings, of which the dates extend from 1814 to 1842; a
may notice, in passing, that among the drawings presented
Sheepshanks are some of special interest to the admirers of ou
animal painter, being some of his very earliest pen and pencil dra
and sketches,—almost unique examples of precocity in
'Hound,' for example, inscribed "drawn at five years of age," a
"drawn by E. L. when he was first breeched," a 'Head of a Bu
a 'Group of a Sow and Pigs,' "drawn from nature at the age
years and two months," and so on. The largest of Landseer's pa
here (and one of the largest pictures in the collection) is the 'Dr
Departure—scene in the Grampians,' one of his most characteris
elaborate works, widely known by Mr. Watt's admirable line eng
Among his other pictures are the 'Highland Breakfast,' 'The
Shepherd's Chief Mourner,' 'There's no Place like Home,' 'The
Dogs,' 'Jack in Office,' and one or two more in which not o
power, unrivalled among living painters, of representing the
clothing, and expression of animals, is fully displayed, but al
humour and his pathos. By Turner there are five pictures,
one English—the 'Vessel in Distress off Yarmouth,' 'Line-Fishi
Hastings,' 'St. Michael's Mount, Cornwall,' 'East Cowes Castle,'
'Venice.' By Wilkie there are six pictures, but only one of any
'The Refusal—Duncan Gray,' and that, we are told in the officia
logue, "was in a most dilapidated state from the use of asph
but has been repaired by Mr. Bentley." The six pictures by We
are all good examples of that painter's genius: among them are
excellent companions painted in 1838—'Going to the Fair,'
'Returning from the Fair;' 'The Village Choir;' and 'Sicknes
Health.' By Stothard there are 10 paintings, including several
Shakspere pieces, 'Sancho and the Duchess,' 'Sir Roger de Cov
and the Gipsies,' and two of his most humorous efforts—'John Gi
and 'Tam o' Shanter.' Further, there are 9 examples by Collins,
Constable, as many by Redgrave; 3 each by Stanfield, Roberts,
and Danby; 2 each by Etty, Eastlake, and Creswick; 9 by Ca
11 by Cooke; 9 by Cope; 4 by Uwins, and so on. The dra
which are varied and interesting, are exhibited in a room adj
those which contain the oil-paintings. Among them are some
drawings by Turner, Prout, &c., but the greater part are sketches
studies. To these has recently been added a small collectio
drawings in water colours, the gift of Mrs. Ellison, which is val
not only in itself, but as serving as the nucleus of a comprehen
collection of works in that essentially British line of art.

The National Portrait Gallery, though an entirely independ
institution, will be conveniently noticed here. The importanc
forming a gallery of portraits of eminent Englishmen had long be
insisted on by historical students before it attracted much p
interest or the notice of the government. But thanks mainly t
zealous and persevering advocacy of Earl Stanhope (then Lord Ma
the subject was at length listened to. The Houses of Parliament g
a favourable response to a direct appeal, the government propo
grant for 2000*l*., and the Gallery became a reality. By a trea
warrant dated December 2nd, 1856, a "board of trustees for
National Portrait Gallery" was appointed, and early in 1857
machinery was got into operation, Mr. George Scharf, a gentleman
known to the public by the admirable outlines with which he
enriched many valuable works, but known also to art-students as

the most accomplished of living English art-critics and archæologists, ing appointed secretary and keeper—the real working officer of the stitution. By the end of the year, not only had the whole been got to good working order, but 23 portraits had been hung on the walls the temporary apartments assigned by the government to the llection in 29 Great George Street, Westminster. Of these portraits, 5 were purchased, 8 were donations. Up to the present time (August, 860) 74 more portraits have been added. Of the 97 portraits now in e gallery, 62 have been purchased and 35 donations.

In the commencement of their work the trustees were singularly ccessful: the foundation-stone being laid by the Earl of Ellesmere, the presentation of the famous Chandos Shakspere—which the arl had purchased at the Stowe sale in 1848 for 355 guineas; nd the purchase by the trustees of a characteristic portrait of 'Sir Walter Raleigh,' the picture mentioned by Aubrey, who saw it at ownton, where it remained till its removal to the National Portrait allery.

As little is generally known of the state of the gallery, we will numerate its contents, noting separately the presents and the pur-hases, and commencing with the former. Following Shakspere in rder of time was a portrait of William Wilberforce, by Sir Thomas awrence—a picture left unfinished by the painter, the head, a very orcible one, being alone completed; Viscount Sidmouth, a water-olour drawing by G. Richmond; Spencer Perceval, painted by oseph, from a mask taken after his assassination, and wearing a somewhat death-like but kindly expression: these three portraits were all equests by Sir R. Inglis. James, first Earl Stanhope, the distin-uished statesman, by Sir Godfrey Kneller, presented by the present arl. Thomas Stothard, R.A., by James Green, presented by Mr. . H. Anderdon—a good likeness, as may be supposed from its having elonged to his friend the poet Rogers, at whose sale it was pur-hased by Mr. Anderdon. The poet Thomson, by Paton, "more fat han bard beseems," and heavy-eyed withal. George, first Viscount orrington, painted by Sir Godfrey Kneller, and presented by the resent viscount. John Foxe, the martyrologist, painter unknown, resented by the Society of Antiquaries. Wright of Derby, painted y himself -a second-rate painter, but a cheerful, intelligent-looking an—presented by Mr. W. M. Rossetti. The sculptor Nollekens, ainted by F. Abbott, leaning on his favourite bust of Fox, and holding is sculptor's tools in his hand, presented by Mr. Labouchere. Sir rancis Burdett, by Phillips, a good likeness, presented by his daughter. ord Chancellor Talbot, by Richardson, presented by the Hon. Mrs. . Talbot. The well-known portrait of Sir James Mackintosh, in is robes as Recorder of Bombay, painted by Sir T. Lawrence in 803, presented by the son of Sir James. Robert Burns, also well nown by the engraving, here ascribed to Nasmyth and Raeburn: it ormerly belonged to Burns's friend and publisher, George Thomson, nd was presented by Mr. J. D. Dillon. John Philip Kemble, by ilbert Stuart; and his sister, Mrs. Siddons, painted by Sir William eechey, in 1798: both these were presented by Mr. J. T. Delaine. An excellent head, by Reynolds, of the celebrated Earl of Shelburne, nd first Marquis of Lansdowne, presented by the present marquis. An intelligent and characteristic, though somewhat faded portrait, by Reynolds, of old Admiral Boscawen, presented by Viscount Falmouth. A profile portrait (artist unknown) of General Wolfe, formerly the roperty of the Princess Charlotte, presented by the King of the elgians. A miniature of Athenian Stuart, presented by his son. Keats the poet, painted by his friend Severn, and presented by Mr. Travers. President Forbes, of Culloden, presented by Sir John orbes. Dr. Edward Jenner, by Northcote, presented by Mr. J. C. Moore. Dr. Nathaniel Hooke, presented by Lord Boston. Sir Charles Bell, presented by his widow. John Knox, the gift of the Duke of Buccleuch. James Gillray, the caricaturist, painted by himself, the gift of Col. Bagot. Sir Stamford Raffles, given by his nephew. The Rt. Hon. Thomas Winnington, presented by Sir Thomas Winnington. Sir Francis Chantrey, painted by Phillips, presented by Lady Chantrey. The Seventh Earl of Derby, presented by the present Earl. Matthew Prior, painted by Richardson, presented by the Earl of Derby. Sir Leoline Jenkins, presented by the Rev. J. M. Treherne. And lastly, a medallion by Chantrey, of Henry Kirke White, presented by Dr. Boot.

As will be seen, though with two or three exceptions not of our greatest men, nor of the highest order of pictures, the donations are of an exceedingly interesting kind. But it is manifest that it is upon the purchases that reliance must be placed for keeping the collection up to the mark. All that the trustees can do as regards donations, is o decide whether the person represented has a title to a place among British worthies, and whether the portrait is authentic; and to accept or decline it accordingly. To guard against improper admissions "three-fourths at least of the trustees present at a meeting must approve" of any donation. The purchases, on the other hand, test at once the fitness and the diligence of the trustees. Had the gentlemen selected as trustees been merely "distinguished patrons of art," habitués of the picture galleries, the spirit of dilettantism would have ed them far astray before they could have been checked by public opinion. But among them were included politicians of all parties, historians, antiquaries, artists, and connoisseurs. The original trustees were—The Lord President of the Council for the time being; the Marquis of Lansdowne; Earl Stanhope; Earl of Ellesmere; Lord Elcho; Right Hon. Sidney Herbert; Right Hon. B. Disraeli; Lord Robert Cecil; Lord Macaulay; Sir Francis Palgrave; Sir Charles Eastlake, P.R.A.; William Smith, and W. H. Carpenter, Esqrs. On the death of the Earl of Ellesmere, in 1857, Mr. Thomas Carlyle was appointed to supply the vacancy; and on the death of Lord Macaulay the vacancy was filled by the election of Mr. Gladstone. As might be expected, therefore, there has been no partisan or sectarian exclusiveness in their selections. The first regulation which the trustees laid down for their guidance was "in either making purchases or receiving presents, to look to the celebrity of the person represented rather than to the merit of the artist. They will attempt to estimate that celebrity without any bias to any political or religious party. Nor will they consider great faults and errors, even though admitted on all sides, as any sufficient ground for excluding any portrait which may be valuable as illustrating the civil, ecclesiastical, or literary history of the country." The second that "No portrait of any person still living, or deceased less than ten years, shall be admitted by purchase, donation, or bequest, except only in the case of the reigning sovereign, and of his or her consort, unless all the trustees in the United Kingdom, and not incapacitated by illness, shall either at a meeting or by letter, signify their approbation."

These were their rules, the following are their purchases. The Raleigh we have mentioned. The next purchase was Handel, by Hudson (the master of Reynolds), the great composer being represented in full dress, with gold lace and ruffles—the dress he used to put on when he sat down to compose a work of more than usual grandeur. Dr. Parr, by Dawe, a rough, course head, bought of Parr's nephew. Arthur Murphy, by Dance. The Speaker Lenthall, from Burford Priory, the seat of the Lenthall family. Horne Tooke, by Hardy. Mead, the physician, by Allan Ramsay, 1740. Robert Harley, first Earl of Oxford, by Sir Godfrey Kneller. Sir William Wyndham, by Highmore. The first Earl Cadogan, by Laguerre. Richard Cumberland, by Romney. La Belle Hamilton, a copy by Eckardt from Lely, which might very well have been left unpurchased. William Huskisson, by Rothwell (1831). Archbishop Wake, probably by Gibson. Bishop Warburton, by C. Phillips: by the way there are at Hampton Court two portraits of a brother prelate, Hurd, whose name is indissolubly associated with Warburton's, one of which might well be sent to renew the companionship here. William Sharp, our best portrait engraver, by Lonsdale. Our great circumnavigator, Captain Cook, painted by John Webber, R.A., who accompanied him as draftsman. Sir William Chambers, the architect, by Reynolds. Elizabeth Carter, the Greek scholar, a crayon drawing by Lawrence. Bishop Hoadley, by Mrs. Hoadley, but, as is believed, touched on by Hogarth. Cardinal Wolsey, a profile formerly at Weston, Warwickshire. General Ireton, by Walker, a stern, grave face admirably painted—from the Lenthall collection. William Pulteney, Earl of Bath, by Reynolds, but sadly faded. Sir William Windham, a fine manly head, by Lawrence, an early work, and more solidly painted than his later pictures. Theodore Hook, by Eddis. Sir Ralph Winwood, a very characteristic head, by Mirevelt—engraved by Vertue. Nell Gwynne, by Lely. The Princess Charlotte, by Dawe, the first of the many portraits which he painted of the princess, and retained by him till his death. Lord Clive, by Dance: the calm decision of the great commander well marked. Sir Joshua Reynolds, painted by himself before his visit to Italy, and consequently before the injury to his lip, which gives so peculiar an expression to his face in subsequent portraits: in all respects an admirable painting, as a work of art one of the very finest in the collection. Sir David Wilkie, a small but characteristic head, painted by himself at the age of twenty-nine. John Opie, R.A., painted by himself at the age of twenty-four—of no great value as a painting, but with the others serving as a good foundation for a series of portraits of British painters. Henry Wriothesly, Earl of Southampton, the friend and patron of Shakspere, by Mirevelt (or, as we fancy, by Mytens). Judge Jeffreys (as Recorder of London), by Kneller. John Dryden. William Harvey, the discoverer of the circulation of the blood. George Colman, by Gainsborough. James I., when a child. Sidney's Sister—Pembroke's mother, so at least it is described in the catalogue, on what authority it is not stated, and the ascription is very far from satisfactory. William Powlett, first Marquis of Winchester. Antony Ashley, first Earl of Shaftesbury. Congreve, by Kneller. Sir Robert Walpole, by Vanloo. Elizabeth of Bohemia, by Janssens. Lord Nelson, painted at Vienna in 1800, by H. Füger. Abraham Cowley, by Mr. Beale. Earl Howe, by Singleton. John Selden. John Hunter, a capital copy, by Jackson, of the celebrated portrait by Reynolds—now a ruin. James, second duke of Ormond. The Seven Bishops, painted immediately after their acquittal. John Smeaton, with the Eddystone lighthouse in the distance. Warren Hastings. David Garrick. James Watt, by De Breda. Dr. Darwin, by Wright of Derby. Sir M. I. Brunel, by Drummond. Archbishop Tillotson, by Mrs. Beale. William Huntington—Sinner Saved. Sir William Herschel, by Abbot. Mary Queen of Scots. And finally, John Howard.

We have gone through the entire list of portraits in the gallery up to August of the present year. To them is however to be added, Hayter's large picture of the 'First Reformed House of Commons,' which was purchased by the government on the recommendation of a Committee of the House of Commons, in order to add to the National containing a large number of the leading politicians whose names are associated with the Reform Act, and other important measures which have acquired an historical interest. But we may regard the admission of this picture as important chiefly as forming a precedent for the introduction of a most valuable class of works, those namely which are strictly contemporary representations of historical scenes or circumstances, instead of exclusively restricting the gallery to portraits; though this should be the only deviation permitted.

This list will have shown that an excellent commencement has been made in the formation of a National Portrait Gallery. Many of our greatest names are wanting, and the trustees have been censured for purchasing portraits of second or third-rate men, while there are no portraits of Bacon, Newton, Milton, and others of the highest order. But it must not be forgotten that authentic portraits of such men are, as has been said, almost as difficult to meet with as the men themselves; and the trustees appear to be fully alive to the importance of securing the portraits of our greatest men. An annual grant of 2000*l.* is made for the purposes of the gallery; but the trustees, desirous of availing themselves of opportunities for large acquisitions by "a sale at some great country-house, or a dispersion of some celebrated collection," do not expend this sum unless portraits of unquestionable importance offer. On the whole, there can be little hesitation in acknowledging, on looking through the list of their purchases, that the trustees have acted up to the spirit of the rule they laid down for their guidance, and that the selection has been made in a liberal and comprehensive spirit. At present the pictures are placed in apartments in a private house, No. 29 Great George Street, Westminster, which barely afford room for those already obtained, and are most unsuitable for their public exhibition. Until sufficient room is obtained no attempt can be made to arrange the portraits in any chronological order or series. When adequate room is provided we may hope to see added to them at least a selection from the British portraits now hung out of sight over the stuffed birds in the British Museum. In the National Portrait Gallery, portraits of Queen Elizabeth, Oliver Cromwell, William the Third, Cranmer, Drake, Algernon Sidney, Marlborough, Bacon, Newton, Locke, Pope, and the like, would find a fitting home and associates; whereas nothing can possibly be more inappropriate than their present locality. It cannot be said that these portraits are inalienable or irremovable, for in the National Gallery there is at least one portrait "deposited by the Trustees of the British Museum," and that of one (Sir William Hamilton) who, from his connection with one of the collections in the British Museum, it might have seemed especially desirable to retain in that institution. And why might not the British Portraits in the National Gallery be also transferred to the National Portrait Gallery? Among them are several of considerable interest on account of the persons represented, yet of but inferior consequence as works of art. The property in these portraits might of course be retained by the respective trustees, although united in this gallery. If this were done, a noble National Portrait Gallery might be at once opened, and owners of the portraits of eminent British worthies would soon be found eager to add their contributions to the national collection.

Hampton Court.—There remain two other galleries which, though not strictly, are virtually national—those at Hampton Court Palace, and Greenwich Hospital. The paintings at Hampton Court are the property of the crown, and the bulk of them are those which have been removed here from the other royal palaces. In all they are no less than 1850 in number. For the last twenty years the whole of the state apartments, in which the pictures are hung, have been thrown openly freely to the public. The grand feature of the collection is the unrivalled series of seven Cartoons of subjects from the Life of the Saviour and the Acts of the Apostles, by Raffaelle, which are by universal consent admitted to rank as the noblest works of their class in the world. They have until lately been seen to great disadvantage in the room built expressly for them by Sir Christopher Wren. But recently they have been lowered considerably, to the manifest improvement of their appearance. It has also been deemed advisable to cover them with glass, which however, whatever may be said on the score of security, can hardly be commended as adding to their beauty.

Next in importance to Raffaelle's cartoons are those by Mantegna of the 'Triumphs of Julius Cæsar,'—a series of nine large grandly executed coloured drawings, but unfortunately in a sadly dilapidated condition. The collection of oil-paintings is of the most miscellaneous character possible. It includes specimens of every variety of merit and demerit attributed to painters of almost every age, school, and grade, from Francia and Raffaelle, Sebastian and Michel Angelo, Mabuse and Holbein, Titian and Tintoretto, Vandyck and Vandevelde, Lely and Kneller, Gainsborough and West, down to Parcelles and Huggins. It is needless to repeat what has been a thousand times said, that the correct attribution of great names is the exception here. But as the gallery is opened for public instruction, it is much to be regretted that a thorough re-examination of the entire collection, with the aid of such documentary evidence as may be in existence, is not made, and what is then believed to be the true name of the painter affixed to every picture which it is deemed advisable to retain for public and an historical point of view—might well be consigned to oblivion. Such a re-examination would permit of two things—each important in its way. First, the formation of a comparatively small collection of paintings valuable as works of art; and next, of a collection of portraits and contemporaneous delineations of historical occurrences of singular value and interest. The really authentic portraits here probably number some hundreds; and they include many by Holbein of Henry VIII. and members of his family and court; others of almost all our monarchs down to George III., including several remarkable ones of Mary, Elizabeth, and the first James, one of the duplicates of Vandyck's grand equestrian portrait of Charles I., and a large and most ambitious equestrian portrait of William III., by Kneller. Then there is Sir Peter Lely's famous series of the 'Beauties of the Court of King Charles II.' and Kneller's of those of the Court of Anne; besides a vast number of eminent Englishmen down almost to the present day, and many eminent foreigners connected more or less closely with English history or literature, as Francis I., Frederick the Great, Erasmus, &c. In looking over these portraits it is impossible not to wish that some of them—such, for instance, as the fine portrait of Newton—could be transferred to the National Portrait Gallery (and the removal of the Admirals to Greenwich is an excellent precedent); but whether that be possible or not, it would be comparatively easy to sweep out anything that is irrelevant from the spacious Queen's Gallery, and by adding to the many old portraits it already contains such as were suitable from the other apartments, and arranging them all in strict chronological sequence, to make it what it would then at once become, the finest English historical portrait gallery in existence, and one which in its way would not be likely to be superseded.

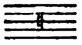
Naval Gallery, Greenwich Hospital.—Mainly, if not wholly, through the exertions of the late Mr. Edward Hawke Locker, the son of a distinguished admiral—himself a man of high taste and of singular energy in every good work—this gallery of portraits of distinguished naval commanders, and pictures of naval actions, was founded in 1823, in the most suitable of all localities, the Painted Hall, Greenwich Hospital, of which noble institution Mr. Locker was a commissioner. George IV., to whom the scheme was submitted, gave it "his cordial approval," and what was still better, transferred to Greenwich Hospital the extensive collection of portraits of the principal admirals of the reigns of Charles II. and William III. at Windsor Castle and Hampton Court. He subsequently added several pictures from his private collections, including Turner's grand 'Battle of Trafalgar.' The royal example found liberal imitators; and the collection is now a large and very interesting one. In looking at the pictures, it should be borne in mind that *every* picture has been presented to the Institution, the Commissioners regarding the funds of the Hospital as "exclusively devoted to the maintenance of the establishment." Beginning with portraits of Willoughby, Nottingham, Raleigh, Hawkins, Drake, and Cavendish, and with a representation of the 'Defeat of the Spanish Armada,' we have in chronological order almost all our bravest admirals, and many of our most famous sea-fights. A small anteroom is called the Nelson room from its containing portraits of Nelson, and several of his brother admirals, and a series of representations of leading events in his career. In such a gallery it is not artistic excellence we look for, and, while there are many excellent pictures here, some of the paintings are very far indeed from claiming to rank as works of fine art. But the visitor must have a strangely-constituted mind who can stand in this noble Hall and gaze around without receiving impressions deeper and more vivid than any produced by the most beautiful pictures when merely regarded as works of art.

The Dulwich Gallery, or Bourgeois collection of Paintings, is not a national gallery; but being open to the public on the same footing as the South Kensington galleries, and having a special character as a gallery of pictures, it seems fairly entitled to mention here. The collection was formed by Noel Desenfans, an eminent picture-dealer, by whom it was bequeathed to his friend Sir Francis Bourgeois, a painter of some note in his day, though of but slender ability as an artist. [BOURGEOIS, SIR FRANCIS, in BIOG. DIV.] Sir Francis dying in 1811, bequeathed the collection to Dulwich College; together with the sum of 2000*l.* and the reversion of other property for the purpose of erecting a gallery to contain the pictures, and a mausoleum for himself and Mr. and Mrs. Desenfans. The gallery in which the pictures are contained, and the adjoining mausoleum, were built accordingly from the designs of Sir John Soane. The gallery is a suite of five long but narrow rooms, sufficiently spacious perhaps for the pictures, which are for the most part of small size, but very insufficiently lighted. The collection itself comprises 355 pictures; some few of the paintings are by Italian, Spanish, and English artists, but the special interest of the collection arises from its consisting chiefly of Dutch and Flemish pictures of cabinet size—a class of works in which the National Gallery is very deficient. Most of the more eminent painters of the Netherlands are represented here, and of many there are very fine examples; but many of the pictures have small claim to the names they bear. and altogether the collection cannot be ranked among those of the highest order.

NATIONS, LAW OF. [LAW.]

NATRON. *Trona.* A commercial name formerly used to desig- te a native sesquicarbonate of soda obtained from Egypt.

NATURAL, a musical character, thus formed—



e use of which is, to make a sharpened note a semitone lower, and a ttened note a semitone higher; or, in other words, it brings into the ale of the natural key of C any note which had been made sharp or t. But it must be observed, that the power of this character does t extend beyond the bar on which it appears, except where a lasting ange of key is intended, in which case each natural placed at the ef removes a corresponding sharp or flat permanently, or until such arp or flat shall be restored in like manner.

NATURAL PHILOSOPHY. [Physics.]

NATURALISATION, from the Latin *Naturalis*, natural. "If an ien be naturalised," says Coke (Co. Lit., 129, *a*), "he shall be to all tents as a natural subject, and shall inherit as if he had been born ithin the king's legiance." [Allegiance.] This rule, however, is bject to some limitations. [Alien.]

Formerly there could be no naturalisation except by Act of arliament; but a simple and inexpensive method of obtaining similar lvantages to those possessed by naturalised subjects has been pro- ded by the statute 7 & 8 Vict. c. 66. This Act enables any alien ho has come to reside in the United Kingdom with a view of settling, present a memorial to the secretary of state, containing a statement his age, profession, trade, or other occupation; the length of time e has resided in this country, and the ground on which he seeks to tain any of the rights of a British subject; and praying for a certi- cate, which must be granted before further steps can be taken. The rtificate granted by the secretary of state recites such parts of the emorial as, after due investigation, are found to be true and material, d professes to confer upon the applicant the rights and privileges of British subject, except the capacity of being a member of the Privy ouncil, or a member of the Houses of Parliament, and except the ghts and capacities (if any) specially excepted in and by such certi- cate. This document must be enrolled in the Court of Chancery, d within sixty days after its date the memorialist must take and bscribe an oath of allegiance. It is considered to confer on the alien temporary character only as a subject; that is, the alien cannot, on turning to his own country, there claim the protection of the British ag as if he were a natural-born subject. The course of proceeding to e adopted by aliens wishing to become naturalised is left, so far as etails are concerned, to the Secretary of State, and the fees are fixed y the Lords of the Treasury.

The number of foreigners naturalised previous to the passing of 7 & 8 ict. c. 66, did not on an average exceed seven or eight a-year, and the umber who applied for letters of denization did not exceed twenty-five nnually. It may be added, that that statute naturalises *de facto* any lien woman who marries a British subject, in consequence of which, he notorious Mrs. Manning, when indicted with her husband for urder, was held not entitled to a jury *de medietate linguæ*.

NATURE, LAW OF. [Law.]

NAUMA'CHIA, the representation of a sea-fight among the Romans, hich was sometimes performed in the Circus Maximus or amphi- heatre, water being introduced sufficient to float ships, but more fre- uently in places made especially for the purpose, which were called aumachiæ. Julius Cæsar appears to have been the first who gave a epresentation of a sea-fight on an extensive scale. He dug a lake in he Campus Martius for the purpose, which however was filled up in is lifetime (Dion Cass., xl. 23; Suet., 'Jul.,' c. 39, with Casaubon's ote, and c. 43). Augustus also dug a lake near the Tiber for the same urpose, which was afterwards turned into a park or plantation '*nemus*;' Suet., 'Oct.,' 43; Tacit., 'Ann.,' xii. 56). Another lake was ug in the Campus Martius by Caligula (Dion Cass., lix. 10); but laudius exhibited a naumachia on the lake Fucinus, now Celano. Suet., 'Claud.,' 21; Dion, lx. 33; Tac., 'Ann.,' xii. 56.) The old aumachia (*vetus naumachia*), in which Titus is said by Suetonius 'Tit.,' 7) to have exhibited a sea-fight, has occasioned some dispute mong the learned; some understanding it to be the Circus Maximus, nd others the lake dug by order of Augustus (Ernesti on Suet. 'Tib.,' 2). Domitian appears to have been the first who erected a building f stone around these artificial lakes (Suet., 'Dom.,' 4, 5). Previous to is time the spectators appear to have sat upon wooden benches, which night be easily made to rise gradually above one another with the arth which had been dug out of the artificial lake. In later times the aumachiæ were usually surrounded with buildings like the amphi- heatre or circus.

The ships which were engaged in these sea-fights were divided into wo parties, which were called respectively by the names of different aritime nations, as the Tyrian and Egyptian fleets (Suet., 'Jul.,' 39), he Sicilian and Rhodian (Suet., 'Claud.,' 21), &c. The combatants, ho were called Naumachiarii (Suet., 'Claud.,' 21), were usually cap- ives or criminals, who fought to death, unless saved by the clemency f the emperor. These sea-fights are said to have been exhibited on uch a scale of magnificence and splendour as almost to surpass our elief. In the naumachia exhibited by Nero there were sea-monsters wimming about in the artificial lake (Suet., 'Nero,' 12), and Claudius caused a Triton, made of silver, to be placed in the middle of the lake Fucinus, who was made, by machinery, to give the signal for attack with a trumpet. (Suet., 'Claud.,' 21.) In Domitian's naumachia the number of ships engaged was almost equal to two real fleets (*pæne justæ classes*, Suet., 'Dom.,' 4); and in the sea-fight on the lake Fucinus, there are said to have been no fewer than a hundred ships, and 19,000 combatants. (Tac., 'Ann.,' xii. 56.)

NAVAL ARCHITECTURE. [Ship.]

NAVE. [Church.]

NAVIGATION. The history of the compass is the history of the rise and progress of navigation. Under that head (Compass) we have already shown the developments which in course of time enabled the mariner to abandon the tediousness of a coasting voyage, when desirous of reaching a distant port, and to avail himself boldly of such aids as the resources of the period afforded for ascertaining his position by celestial observation and the use of charts.

Certain it is that navigation was practised as an art, by the sailors of the East, previous to the voyage of Vasco de Gama round the Cape of Good Hope, during the 15th century.

The publication of Napier's tables of logarithms, in 1614, may fairly be considered as the origin of the present system by which ships are navigated to distant parts, although at that period and long afterwards, the want of better instruments was a great detriment to the seaman whose facilities for computation far exceeded in amount those for observing the celestial bodies:—for although Hadley's quadrant was described in the 'Philosophical Transactions,' so early as 1731, some years elapsed before its use became general among those who from habit had been content with the cross-staff or the fore-staff. Indeed it was not until the close of the last century that the cross-staff fell into disuse.

It is somewhat singular that this order of things has been reversed in so pre-eminently maritime a country as Great Britain; for at the present time the perfection of instruments has contributed more especially towards increased accuracy by observation, while it is to be regretted that computation has been allowed to retrograde.

Before entering upon any details as to the art itself, it will be well to glance at those who are called upon to practise navigation. Under the heading Great Circle, or Tangent Sailing, we have already adverted to certain unsatisfactory circumstances connected with the present state of nautical education as affecting the real question and interests of navigation. Possessing the finest merchant service in the world we are absolutely deficient in that essential educational groundwork, which can alone constitute in any individual the complete navigator. The Board of Trade perceiving the insufficiency of the general education of those who, necessarily leave school at an early age to join the sea service, wisely instituted a system of examination for sea officers, and the merchant has already learnt to appreciate increasing competency in ship-masters who, stimulated by the desire of honourable public mention, have obtained *extra* certificates. But it is to be lamented that deeply rooted impediments exist in the path of progress which it would be well to remove. These are never so apparent as when we attempt to compare the English system of education with any foreign one. If we seek a standard for comparison we have it in the corresponding classes of men who occupy the same relative maritime position as those of our own country.

To say that navigation is the art of moving a ship from one part of the ocean to another, is the usual prefatory definition; but so various are the methods by which such changes are effected that these are, as a whole, justly considered as an art. For instance;—it is easy to convey a vessel from a port or place to a not far distant headland, or along a coast several points of which lie within sight of the usual track of the vessel. To do this is the mere work of a sailor or one accustomed to the management of the masts and sails, &c., so as to be able to steer in the right direction. Of such nature was the work of our earliest navigators, before the compass came into general use. But even in these short passages it will sometimes occur that heavy gales drive the mariner beyond the limits of his knowledge of the locality as depending upon sight of land, and throw him upon some extra resources, such as he can obtain by loose speculations founded on the appearance of the heavenly bodies, or by the use of the lead-line. A very large portion of master mariners are of this class; they plod their way about our coasts, ignorant of any scientific means whatever of navigation. Others, again, traverse the English Channel, the Irish Sea, the North Sea, &c., and have so far consulted *system* as to have acquired the rough knowledge of a quadrant and the method of taking by it a meridian altitude for the latitude: with this, and the occasional use of the lead-line, together with some such slight initiation into plane sailing as can be gathered from an ordinary epitome, this very large class of navigators perform their voyages not only with celerity but certainly with marvellous safety and regularity. Simple, however, as the nautical operations of these may appear to the mere landsman, a vast amount of valuable local knowledge is treasured in their memories. Nor is this local knowledge to be mistaken for the mere ability to recognise points of land, or glimpses of the coast or lighthouses, &c.; but it is the deep study of the ocean bed which constitutes mainly the highest attainment of the so called over-sea pilot. This together with an acquaintance with the peculiarity of the tides, so variable in their courses along the coast line, and a knowledge of their periodical ebbings and flowings over or about various dangers, constitutes the study of a lifetime; so that we, when speaking of the oldest pilot, seem to imply the ablest pilot—as the ability referred to is attainable only by long observation and experience. Some masters of coasting vessels are of a still higher grade as regards education, inasmuch as when the vessels they navigate are of the burden of 100 tons, not only must the master himself have received a certificate of examination by officers of the Board of Trade, but one other officer, at least, in the vessel must be also certificated. Perhaps no other nation possesses so large a number of these daring and devoted seamen; trained in all weathers and in all seasons, they acquire a position among unpretending navigators, which would render comparison of them with those of other nations a source of pride and congratulation.

It is remarkable, that while miners and manufacturers have their special schools, surgeons their colleges, men of law their inns of court; the clergy, their universities; the over-sea-officers, or ocean navigators, a body of men who form a large majority of the ship-masters of England, have no suitable schools of navigation. Teachers are not wanted, it is true, but it is what they teach, or rather what they *do not teach* that specially needs public attention. In all other branches of science, a knowledge of the *why and the wherefore* is deemed indispensable to the proficiency of the student, but in navigation alone, a person is absolutely doomed to work blindfold, as regards the very ground-work on which all practical navigation rests. For not only do the very best works in use set at nought the necessity for a proper foundation being laid in the doctrine of spherics, and projection in particular, but in the highest examination of a captain by the Board of Trade for an extra certificate, it is required only that he be able to explain enough of spherics to illustrate the nature of great circle sailing: he is "*not required to go into the calculations.*" It is no reproach to our rulers that such is the case. Evils so extensive have not been the growth of recent years. Remedies are yet required. The establishment of institutions of a higher order for instruction would tend to remove such evils, and would inevitably promote the production of works of a superior character.

In navigation we have to deal with changes of a ship's position as sailing upon a spherical figure. It may be said, that the formulæ used in Mercator's, or middle latitude sailing, are sufficiently simple for general practice; yet how few in the merchant service can even construct the figure. And again in great circle sailing, who would not prefer seeing a merchant captain, when desirous of finding his tangent course, use an elegant, short, but exceedingly simple method by construction, which he *would* understand, to the more tedious method of calculation which he *would not* understand. Of far more importance is it to the nautical astronomer, who alone deserves the name of navigator, to clearly comprehend the nature of spherical trigonometry. All his problems and daily observations are the practice of spheric operations. The imaginary lines of the "vast concave" are designated and estimated by terms derived from the doctrinal attributes of the sphere. If then we inquire how an ordinary so-called navigator makes use of celestial observations while totally ignorant of principles, we are constrained to a confession, which, were not the ship-masters themselves loudly complaining of its truth, would stigmatise our mercantile marine, while the onus of the defect actually rests, not with them, but with the votaries of science themselves. How can it be, that while 200 years since every work on navigation taught spherics both by projection and calculation, in 1860 not a work in this great country gives the same facilities for a seaman's use?

The cause of this may be thus traced. Towards the close of the last century, various elegant diagrams for the aiding of the mariner by saving the labour of calculations were published in England. As an example, the perhaps most elaborate and in themselves most ingenious of them were by Margett in about 1772. A means of working, which was totally independent of calculation, soon began to be found a convenience to sea officers. Those of the greatest school of navigation ever formed, namely, the officers of the late East India company possessed such pleasant and interesting aids as Margett's 'Tables of Longitude,' and more recently, sets of 'Linear Tables,' &c. &c.; these gradually superseded calculation by logarithms in operations derived *directly* from the doctrines of the sphere. [SPHEROGRAPH.] And again, ingenious formulæ sprung from various equational combinations, hiding from the mind's eye their palpable origin, until now, the sailor unfortunately has nothing else to rely on. These formulæ are, still more unfortunately, considered useful in proportion as they become condensed and shorter. We have thus blindly and unconsciously offered a premium to mathematicians for the obscuration of those principles of which a proper knowledge is now claimed on behalf of navigators. The abridgment of formulæ in itself is not to be stigmatised; it was, however, in the circumstance of such abridgments occurring just at a period when diagrams entered largely into the practice of the day, in which lay their danger. Nor do we complain of diagrams, merely as such, but the great evil has been the publication of such as illustrate no system, or assist in no elementary study. If they had helped in the demonstration of spheric principles, calculation itself would have been simplified and retained in practice. A very long experience in educational matters enables the writer (who for upwards of thirty years has anxiously watched the question, being himself a navigator), to assert that all nautical diagrams which are not *palpably* deduced from the projections of the sphere, namely, stereographic, orthographic, and gnomonic, have a baneful while on the contrary, such diagrams as are really illustrations demonstrative of, spherics, cannot be too plentiful. It follows that the present generation of navigators want assistance in It may be suggested that to attempt a sudden remedy impolitic. The authorities might, however, as a first step in their examination of an ocean captain, to see that he knew stereographic projection to enable him to answer ordinary spheric construction. But everything that can be done to stereographic projection is worthy the encouragement of the Trade. Navigation therefore, as a branch of highly important science, does not at present in England take its legitimate Young sea officers require a peculiar education. The Admiralty have taken the initiative, and in H.M. Navy, the which affect the merchant service do not exist. It is a that whereas in other professions, experience increases principles; in navigation, the older practitioner knows less than the young sailor fresh from his examination.

As regards the nature of the operations used in conducting course at sea, we give details under various heads, such as DEPARTURE; GREAT CIRCLE OR TANGENT SAILING; LONGITUDE; LEAD-LINE; LOCAL ATTRACTION; LOG AND LOG-BOARD AND BOOK; SAILING, &c.; to which we refer.

NAVIGATION LAWS. [SHIP AND SHIPPING.]

NAVY. A few leading facts as to the rise and progress British navy will form a fitting introduction to the main present constitution and force.

In the early part of the Christian era, so rude was the vessels, and so inadequate were they to contend with the and waves, that it was not until the reign of the emperor A.D. 276–82, that the veil of terror hanging over the ocean and voyages was removed. That emperor, in pursuance of his colonising the border lands, which were exhausted by war, with from the crowded countries of the barbarians, had carried a Franks into Pontus, with a view of defending that country Alani. Love of home induced some of these people to return; they seized ships on the Euxine, and plundered the Greece, Asia, and Sicily, either to supply their wants or for passing the pillars of Hercules, they veered to the right, and their voyage by disembarking at the mouth of the Rhine. voyage we may date the origin of nautical enterprise. The took advantage of the rich harvest thus opened to all who would the Roman provinces by sea, and ravaged the coasts to such an as to oblige the Romans to establish a fleet in the English repel them. After the Saxons had been long in possession of they lost their naval arts, and in their turn became a prey constant attacks of the Sea-kings, Vikingr, and other pirates. no record of the size or number of the vessels which sustained conflicts with the Danes in the 9th century. Alfred the Great founder of the English navy. He first perceived the fleet to protect the coast from the swarms of pirates in the seas. A slight advantage gained by some ships of his over the in 876, induced him to build long ships and galleys, which, countrymen were not competent to manage them, he manned with piratical foreigners as he could engage. After he had driven Danes, he applied his talents to improve his ships, and built higher, longer, and swifter than before, some rowing thirty oars, others more. Ethelred made a law that whoever 310 hydes of land should furnish and build one vessel for the the country.

William the Conqueror established the Cinque Ports, and gave certain privileges on condition of their furnishing 52 ships for in case of emergency. King John claimed for England the of the seas, and declared that all ships belonging to foreign which should refuse to strike to the British flag, should be and lawful prize. In the year 1293, an English sailor killed in a French port, war ensued, which it was agreed to naval action, which was fought in the middle of the Channel, English, being victorious, carried off above 250 sail. In King Edward III. with 240 ships was on his voyage to Flanders, in with and completely defeated, off Sluys, the French fleet of manned with 40,000 men. The same monarch blockaded Brest 730 sail, containing 15,000 men. Many of the ships fleets were Genoese and Venetian mercenaries, but they must been very small, and the numbers of ships and men are exaggerated. Henry V. had something of a navy, for we find the records in the Tower, a grant under his hand of annuities to maistres of certaine of our owne grete shippes, carrakes, barges ballyngers." Henry VII., who succeeded in 1485, seems to have the first king who thought of providing a naval force which at all times ready for the service of the state. He built the Harry, properly speaking the first ship of the royal navy; 15,000*l.*, and was accidentally burnt in 1553. Henry VIII. the designs of his father. He constituted the Admiralty and Office, established the Trinity House, and the dockyards of Woolwich, and Portsmouth; appointed regular salaries for the captains, and sailors; and made the sea service a distinct he also made laws for the planting and preservation of timber. In 1412, when a fleet was fitted out against France, under Sir Edward Howard, lord-high-admiral, the following allowances were made:—

	s.	d.
For his own diet, maintenance, wages, and rewards, per diem	10	0
Each captain for ditto, ditto	1	6
Every soldier, mariner, and gunner, for his wages per lunar month	5	0
And for his victuals	5	0

The ships of this period were high, unwieldy, and narrow; their guns were close to the water, and they had lofty poops and prows, like Chinese junks, insomuch that Sir Walter Raleigh informs us "that the Mary Rose, a goodly ship of the largest size, by a little sway of the ship in casting about, her ports being within 16 inches of the water, was overset and sunk." This took place at Spithead in the presence of the king, and most of her officers and crew were drowned. The Henri Grace de Dieu, the largest ship built in this reign, is said to have measured above 1000 tons. At the death of Henry VIII., the tonnage of the navy was 12,000 tons. Elizabeth increased the navy greatly. The fleet which met the Spanish Armada numbered 176 ships, manned by 14,996 men; but these were not all "shippes royal," for she encouraged the merchants to build large ships, which on occasion were converted into ships of war, and rated at 50 to 100 tons more than they measured. She raised the wages of seamen to 10*s.* per month. Signals were first used in this reign as a means of communication between ships. In 1603 the navy had 42 ships, measuring 17,000 tons. In the reign of James I. lived the first able and scientific naval architect, Phineas Pett, and the king had the good sense to encourage him. Pett introduced a better system of building, and relieved the ships of much of their top hamper. Before the civil wars broke out, Charles I. built the Sovereign of the Seas, of 100 guns, and measuring 1637 tons. In this reign the navy was first divided into rates and classes. Cromwell found the navy much reduced, but his energy restored it, and he left 154 sail, measuring 57,643 tons, of which one-third were two-deckers. Cromwell first laid before parliament estimates for the support of the navy, and obtained 400,000*l.* per annum for that purpose. The navy flourished under Charles II., with the Duke of York at its head, assisted by Samuel Pepys, as secretary, until 1673, when the duke's inability to take the test oath caused his retirement, and the king's pecuniary difficulties leading him to neglect the navy, it fell into decay. The Duke of York was recalled to his post in 1684, and at his accession in the following year there were 179 vessels, measuring 103,558 tons. James II., on coming to the throne, took active measures for the restoration of the navy; he suspended the Navy Board, and appointed a new commission, with which he joined Sir Anthony Deane, the best naval architect of the time, who essentially improved the ships of the line by copying from a French model. Four hundred thousand pounds per annum were set apart for naval purposes, and so diligent were the commissioners that at the Revolution the fleet was in excellent condition, with sea stores complete for eight months for each ship. The force was 154 vessels, carrying 6930 guns, and 42,000 men. Of these vessels nine were first-rates.

William III. immediately on being placed on the throne went to war with France, whose navy was then very powerful; in 1681 it consisted of 179 vessels of all sorts, carrying 7080 guns, besides 30 galleys. An Act was passed in his second year, for building 30 ships, to carry 60, 70, and 80 guns respectively. The dockyard at Hamoaze, out of which has since grown the considerable town of Devonport, which now returns two members to parliament, was then established. Queen Anne found at her accession the navy to consist of 272 vessels, measuring 159,020 tons, but this estimate includes hulks, hoys, and other vessels not carrying guns. At the death of Anne in 1714, the number of ships was less, but the tonnage increased, being ships 198, guns 10,600, tons 156,640. The parliamentary vote of that year was 245,700*l.*, and 10,000 seamen and marines. During the first four years of George I., large sums were voted for the extraordinary repairs which were required after the long war. A new establishment of guns also was ordered in this reign. The navy remained stationary till 1739, when hostilities commenced against Spain, and the navy was augmented, particularly in the smaller classes of vessels, and the dimensions of several classes were enlarged. War broke out with France in 1744, at which period there were 128 sail of the line. At this time all prizes taken by H.M.'s ships were declared to be the property of the captors. In 1747 a naval uniform was first established. The navy increased vastly during this war, in which 35 sail of the line were taken or destroyed by the English. George III. at his accession found the navy to consist of—

Ships of the line	127	measuring 321,104 tons.
„ 50 guns and under	198	

The vote for the year 1760 was 432,629*l.*, and 70,000 seamen and marines. In the short war of 1762, 20 sail of the line were added to the navy, and at the end of the American revolutionary war it was composed as follows:—

Sail of the line	174	about 500,000 tons.
Under	203	

The navy was kept in a high state of preparation, and when, on the 1st of February, 1793, the French republic declared war against England, this country was not unprepared. A period now commences in which the gigantic efforts made by England, and the protection necessary for a mercantile marine, which almost monopolised the commerce of the world, raised the British navy to such a height as to enable it single-handed to maintain the sovereignty of the seas against all other navies combined. Sir Charles Middleton, afterwards Lord Barham, had, when comptroller of the navy in 1783, established the regulation that a great proportion of stores, sails, &c., should be laid by for each ship in ordinary; so that in a few weeks after the declaration of war there were 54 sail of the line and 146 smaller vessels at sea. The vote for the service of the navy was 5,525,331*l.*, 85,000 seamen and marines. The navy of France had never been so powerful: it amounted to above 200 vessels, of which 82 were of the line, and 71 in addition were immediately ordered to be built. The English had about 115 sail of the line fit for service, but the majority of the French ships were larger and finer, and carried heavier guns on their lower or principal battery. The following abstract will show the losses on both sides up to the peace of Amiens, exclusive of the casual losses:—

	Captured.	Destroyed.
British ships of the line	5	0
„ smaller vessels	37	9
Total	42	9
French ships of the line	32	11
Dutch „ „	18	0
Spanish „ „	6	5
Danish „ „	2	0
Total	58	16
French smaller vessels	266	44
Dutch „	62	6
Spanish „	57	10
Total	443	76

This estimate does not include 807 privateers, chiefly French, taken and destroyed. Of the above, 50 sail of the line and 94 under that size, were added to the British navy.

During the peace of Amiens preparations for war were actively continued on both sides, and the declaration on the part of England was made in the month of May, 1803, at which time the navy was of the following force, as compared with 1793:—

	Ships of line.	Under.	Tons.
1793	153	411	402,555
1803	189	781	650,976

Notwithstanding the apparent increase, there were not so many line-of-battle ships fit for sea at the latter as at the former period by about ten. The French force in serviceable line-of-battle ships in March, 1803, was 66, the British 111. During this war there were employed from 100,000 to 120,000 seamen and marines till 1810, when the number was increased to 145,000. There were about 100 sail of the line, 150 frigates, and above 200 sloops, besides small armed vessels, amounting in the whole to about 500 sail of pendants constantly employed. The following abstract shows the losses on each side during the war:—

		Captured.	Destroyed.
British—	Ships of the line	0	0
	Under	83	7
		83	7
Enemies'—	Ships of the line	55	14
	Under	79	23
		134	37

of which 33 sail of the line and 68 under were added to the British navy.

In George III.'s reign the dockyard of Pembroke was established.

The parliamentary vote for the service of the navy, 1839–40, was as follows:—

Officers	3,400
Petty officers	3,998
Seamen	12,846
	20,244
Marines	9,000
	29,244

For the effective service	£3,492,132
For the non-effective service	1,488,221
Other departments, namely, convicts and transport of troops	217,158
Total charge	£5,197,511

The following tables will show the force of the British navy at three distinct periods, namely, the breaking out of the French revolutionary war; a few years subsequent to the peace; and in 1839: also the naval force of other countries possessing a navy, in 1839:—

RATE.	1793.				1820.				1839.			
	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.
First	1	2	2	5	2	14	7	23	4	14	6	24
Second	4	12	5	21	1	8	12	21	5	10	11	26
Third	21	70	5	96	11	69	3	83	15	31	2	48
Of the line	26	84	12	122	14	91	22	127	24	55	19	98
Fourth	7	5	3	*15	7	7	7	21	2	15	2	19
Fifth	35	44	3	82	14	67	25	106	8	53	8	69
Sixth	15	20	..	35	14	7	18	39	21	3	4	28
Sloops	34	13	2	49	49	62	34	145	45	10	13	68
Steam-vessels	..	..	..	..	..	..	..	..	30	4	10	44
Gun-brigs, Schooners, Cutters	18	..	..	18	15	10	2	27	45	9	12	66
Grand total	135	166	20	321	143	244	108	465	175	149	68	392

Ships of the Line.	FRANCE.				RUSSIA.				AMERICA, U.S.				EGYPT.				TURKEY.				HOLLAND.				DENMARK.				SWEDEN.				SPAIN.				NAPLES.				SARDINIA.			
	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.	In Commis.	In Ordinary.	Building.	Total.
100 guns and upwards	2	4	16	22	5	..	2	7	2	..	..	2	6	2	1	9	2	1	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
80 to 100 guns	5	2	11	18	16	2	5	23	..	2	8	10	2	..	..	2	5	1	..	6	..	2	..	2	..	4	1	5	..	5	..	5	..	1	..	1	..	..	..	..	..	..	..	..
70 to 80 guns	3	4	2	9	19	1	..	20	..	3	..	3	1	..	..	1	3	3	..	6	..	3	3	6	..	1	..	1	..	5	..	5	..	2	..	2	..	..	..	..	..	..	..	..
Of the line	10	10	29	49	40	3	7	50	2	5	8	15	9	2	1	12	10	5	..	15	..	5	3	8	..	5	1	6	..	10	..	10	..	3	..	3	..	..	..	..	..	..	..	..
Frigates.																																												
Razees and 60 guns	5	8	9	22	4	..	..	4	6	9	18	33	7	..	..	7	4	1	1	6	..	2	2	4	..	..	..	..	..	1	..	1	..	2	..	2	1	..	..	1	..	2	1	3
50 and 52 guns	5	7	8	20	..	..	..	..	..	..	..	..	..	..	..	..	3	2	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	2	1	..	..	1	2	..	..	2
36 to 50 guns	6	7	5	18	20	..	1	21	..	2	..	2	..	..	..	..	3	1	..	4	5	6	3	14	..	..	..	..	..	6	1	7	..	..	..	..	..	..	..	..	..	1	..	1
Steam-vessels	22	6	9	37	8	..	..	8	1	..	9	10	1	..	..	1	1	..	2	3	3	..	1	4	..	..	..	..	..	2	..	2	..	..	..	..	1	..	..	1	2	..	..	2
Grand total	48	38	60	146	72	3	8	83	9	16	35	60	17	2	1	20	21	9	3	33	8	13	9	30	..	5	1	6	..	19	1	20	..	7	..	7	3	..	..	3	4	3	1	8

. Holland had 104 gun-boats; Denmark, 67; Sweden, 337.

Until the Restoration there does not appear to have been any precise division into classes, nor have we any account of the armament of ships. At that time certain ships were ordered to be built to carry the following:—

Description of Guns.	1st Rate. 780 men.	2nd Rate. 660 men.	3rd Rate. 470 men.
Cannon = 42-pounders	26	—	—
Demicannon = 32-pounders	—	26	26
Culverins = 18-pounders	28	26	—
Demiculverins = 12-pounders	—	—	26
Sakers = 6-pounders	28	26	—
Forecastle	4	—	4
Quarter-deck	12	10	10
3-pounders	2	2	4
Total number of guns	100	90	70

There was, however, no uniformity preserved; and in 1745 a committee was appointed, which recommended certain changes in the rating and arming, which however were not adhered to any more than the former systems. At the peace the Board of Admiralty represented this to the Prince Regent in a memorial, and a system was adopted; but the introduction of ships of much larger tonnage and wholly different armament has rendered the classification obsolete. The classification now in use is as follows:—

1. *First Rates*, to comprise all ships carrying 110 guns and upwards, or the complements of which consist of 1000 men or more.

   Second Rates, to comprise one of her Majesty's yachts, and all ships carrying under 110 guns and more than 80 guns, or the complements of which are under 1000 and not less than 800 men.

   Third Rates, to comprise her Majesty's other yachts, and all such vessels as may bear the flag or pendant of any admiral superintendent or captain superintendent of one of her Majesty's dockyards; and all ships carrying 80 and not less than 60 guns, or the complements of which are under 800 and more than 600 men.

   Fourth Rates, to comprise all frigate-built ships of which the complements are 600 and not less than 410 men.

   Fifth Rates, to comprise all ships the complements of which are 400 and not less than 300 men.

   Sixth Rates, to consist of all other ships bearing a captain.

2. Sloops:

   To comprise all vessels commanded by commanders.

3. All other ships commanded by lieutenants, and having complements of not less than 60 men.

Smaller vessels, not classed as above, to have such smaller complements as the Lords Commissioners of the Admiralty may from time to time direct.

In 1839 it will be seen that England was in reality no longer able to meet a sudden emergency. The public voice aided the discernment and energy of Government, and a change was resolved on. Prosperity had proved a dangerous narcotic. The question of war or peace had been considered as one of mere national income and expenditure, rather than one of vital importance, as involving our defence and safety. A prevalent feeling that a pressing necessity had arisen led the Government to arm and man a few ships, until they grew into a Channel squadron; and Spithead once more showed to a new generation some results of naval preparation. Then for a time the rulers of England were, from public encouragement, more free to enter upon a wider course, which soon told upon the resources pre-eminently possessed by this country. New requirements of science resulted in immense changes in the form, mode of arming, and propulsion of ships-of-war.

At this period the Vernon frigate was stated in triumph to be larger than a first-rate of the year 1745; the said Vernon being of the measurement of 2080 tons. But so great has been the advance of naval architecture as a science, as compared with preceding years, that in 1860 we find the said Vernon, of 51 guns, lying in the Medway, a mere pigmy in comparison with other frigates, one of which, the Galatea, of 26 guns, is of the burden of 3202 tons.

It is really difficult in a subject of such vast range as that of our navy to select judiciously, or to reject advisedly, details conducive to our purpose. During the last fifteen years the question of naval strength has been growing into huge dimensions, as nourished by the stirring activity of our rulers, consequent upon the immense changes which various causes have produced. Among these causes steam has so deeply influenced all naval matters, that the navy of 1860 cannot easily be compared with that of any previous period; nor is it easy to convey an accurate notion of the extent of such changes within the proper limits of an article in a Cyclopædia. The very lines of demarcation between long familiar terms have been absorbed and obliterated. As an instance, the words corvette, or frigate, or sloop, or brig, &c., give now no positive idea of the powers of ships described by these terms. The lines of construction, the proportions of the extremities, the description of armament, as consisting of solid or hollow shot, or as round or cylindrical, pointed, curved, or truncated,—investigation of all these matters in naval warfare, tending towards greater weight of metal in guns, in order to facilitate longer ranges in projectiles, such ranges still further depending for accuracy upon the peculiar shape of the gun-chamber or bore, whether as circular or hexagonal, &c., or as grooved or rifled,—all these, we say, throw upon the naval architect a demand for change in the forms of vessels, and a mass of considerations, of which his predecessors had little or no experience.

To enter upon the various stages of improvement induced by individual talent would be foreign to our object: it is enough to remark that the names of Seppings, Hayes, Symonds, and others, and especially of the distinguished officer Sir B. W. Walker, late the surveyor of the navy, but who now fills the newly created office of comptroller of the navy, will be remembered with respect by posterity, as having each in his own method promoted, with national advantage, the subject of ship-building for warlike purposes to its present state. The extreme difficulties encountered by the latter during an extraordinary period of total revision of the navy, lay in the required alteration of ships which had been partly or totally built; the cutting of others to lengthen for the reception of screw-engines; the various perplexing circumstances consequent upon failures or even unexpected successes in the scientific experiments of all maritime nations, required the energies and watchfulness of not merely the man of science, but the ready tact and penetration of the accomplished sailor and experienced and observant sea-officer. The exertions of the directing head have been worthy the honours decreed by the nation: while the apparently splendid line-of-battle ships of a neighbouring nation, can scarcely fight their lower-deck guns in rough weather, the British nation now possesses in her royal navy the finest sea boats and floating batteries in the world.

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* In 1793 the fourth-rates on two decks formed part of the line of battle.

We dwell thus upon the importance of these considerations because, when the paddle-ship was first thought likely to supplant altogether the sailing-ship, there arose a sense of uneasiness and doubt of our safety in the minds of those who were most intimate with the progress of affairs, from the consideration that the strength of the old fleet lay in its "broadsides," which, however, the introduction of the paddle nearly paralysed. Hence it became necessary to increase the calibre of the reduced number of guns which a paddle-ship could accommodate. But this, again, demanded total readjustment of the framework of the ship; so that some, to be rendered effective as men-of-war, needed alteration at one end, some at the other, to insure a proper amount of buoyancy in compensation for novelties in the new distribution of weight of metal, &c.

The question of naval architecture for warlike purposes was one of special anxiety in and about 1844. The continental threatenings of the year 1839 had deeply impressed the country with a conviction of insecurity, and the exertions of neighbouring nations stimulated an unusual activity in our arsenals. In that year the sailing properties of certain forms of hull were tested in the construction of five brigs, as 12-gun brigs, intended to compete with three of the 10-gun brigs of the old model, namely, the Pantaloon, Waterwitch, and the old Cruiser.

The new ones were as under, namely :—

Flying Fish .	built by	Sir W. Symonds.
Osprey . . .	,,	Blake.
Espiégle . .	,,	Chatfield.
Mutine . . .	,,	the School of Naval Architecture.
Daring . .	,,	White, of Cowes.

Only two other vessels of the gun-brig class were afterwards built, these were the Mariner and the Kingfisher. From the above period we may date an era memorable in the records of the English navy. Various experiments then commenced became instrumental in forming a fleet, such as the country delighted to hail with acclamation, as it afterwards mustered at a grand naval review at Spithead in August, 1853. This was, however, but a splendid holiday display; nor could the many thousands who beheld that most imposing national spectacle have suspected that before another year a naval armament of England would be led by our Queen in person towards the Baltic, and that her naval supremacy was once more to be put to the test of battle in a war with Russia; but, of the many thousands who waved and cheered this gallant fleet from our shores, some will not forget the one deep sentiment of anxiety, when reminded, on reflection, that, from novelties of armament and propulsion, naval war was then (as it would be now) an *experiment*.

The fleet of 1854 differed from those of former wars. It was not composed of similar materials, either as regards men or ships. In 1854, not only were men wanted to man the fleet, but those who did enter as able seamen were unaccustomed to the very improvements which science had introduced. The work of an engineer in those days could only, in the minds of so peculiar and isolated a race of beings as British sailors, be viewed in the light of innovation. A new round of duties seemed, in 1854, to have descended upon him, or to loom before him. Instead of a splendid fleet of sailing-ships, with which he had, in its details, become acquainted, and whose evolutions, depending upon the smartness of the crews, used to be governed by one set of naval rules, under which his experience had been matured, the fleets of the Baltic and Black Sea were composed of three distinct and separately-managed classes of vessels; where, moreover, the sailing-ships, his former pride, took the lowest rank in point of efficiency, either in sailing or warfare.

In the Baltic fleet the	screw	squadron had	28	ships.
,,	paddle	,,	23	,,
,,	sailing	,,	4	,,
		Total	55	ships.

In the Black Sea fleet the	screw	squadron had	10	ships.
,,	paddle	,,	18	,,
,,	sailing	,,	12	,,
		Total	40	ships.

In 1855, there were in the British navy 107 paddle-steamers, and 78 screws.

Steam, then, had in 1854 established its claims to the attention of our naval administration as a powerful auxiliary at sea. A few paddle-steamers only had attended the Channel fleet of 1845. But, as that fleet passed outside the Nab Light, a long low corvette, of some 700 or 800 tons, was propelled by a force which showed the Rattler to have attained a speed exceeding that of all other vessels present. In her the screw had achieved a triumph; had taken unquestionable precedence over the paddle-wheel, and had established a means of propulsion that was soon to effect a mighty change in the naval forces of Great Britain. The apathy, real or otherwise, which might seem to have attached to the British naval executive through a long peace, and up to 1845, certainly from that year decreased. In 1845 alone, no less than 23 screw-steamers were added to the British fleet, and formed the nucleus of the enormous change to which our attention must be called before our dismissal of that branch of investigation which refers to what the naval force has been.

In 1845, as we thus notice, the Rattler was the forerunner of great changes in the mode of propulsion of our ships-of-war. The paddle-steamers had before that been but partially substituted for the sailing-ship. The exposure of a vessel's sides, and the machinery of the paddle, to the damaging effect of an enemy's shot; the position of her engines, even as questionably protected by her coal-bunkers; the probable destruction of her paddles early in an action; the nature of the crew, sufficient only for a mere steamer; the great diminution in the possible armament of a ship in which so much space was required for paddles, and the consequent interference with that which in naval fights had hitherto worked such destruction in our enemies' ships, namely, the broadside; together with the necessity for arming according to greatly altered lines in the construction of ships destined for steam navigation,—these were serious considerations for an Admiralty Board. They perplexed the question of the precise form of a ship to such an extent, that while the public were speculating on the general improvements which it was not difficult to foresee must spring from such a combination of novel circumstances, enough was on the hands of the executive to have paralysed a body less ably supported. The change from a sailing fleet to one of mechanical propulsion, whatever might be the particular mode in which such propulsion was to be effected, was one of those gigantic movements that had much more influence upon the security of the country than would appear to common observation. The anxiety and occasional fears of statesmen who felt the vital tendency of passing events, the driving of our best sailors from the service, the enormous sums necessary for experiments,—these, and other weighty considerations, increased the high responsibilities of the Board of Admiralty; and it would be unjust to estimate the value to the country of this or that board for the administration of naval affairs on account of failures or expenditure, or on account of delays, which were possibly the result of no want of energy at the time.

While England was thus investigating the question of naval armament, other countries were also vigorously presenting the whole matter to scrutiny and reform. There could be no question as to the recent inferiority of England as regards her defence by sea. Such then was the opportunity for rival nations to push forward their developments. Indeed, no sooner had the war with Russia terminated than all the resources of that country were given to the renewal of her ships, and the recovery of a fleet. Her emissaries were soon to be found in every sea-port in England, and no novelty in science which promised advantage in future warfare, or even in the fitting of ships, was neglected by Russian naval officers. It was no uncommon sight for Russian steamers, built as well in the Thames as elsewhere, to proceed to sea with fittings upon new principles,—so new, that the English ship-owners even had not yet been made acquainted with their existence. It is questionable whether we have any correct notion of the rapid strides thus made by Russia in rebuilding her navy, although certain lists of ships are before the world. The public occasionally had their attention drawn to the movements of other nations, and many disparaging comparisons have taunted our English executive; but, with all things in a state of change, such have been merely inducements in the Lords of the Admiralty to drive forward their experiments. But who can tell the probably enormous sums saved to the country by the cautious and, under circumstances without parallel in history, prudent hesitations which such changes seem now to have justified! The expenditure of vast capital would naturally, to a commercial people like the English, appear suspicious where positive and immediate benefit was not plainly discernible.

Whether the weakness which appeared to infest our sea-service, and the openly avowed discrepancies which were said to exist in the recent working of naval affairs, influenced a neighbouring nation, and, as on former occasions, cherished in her the hope of a future predominance, or not, certain it is that not only in the ships of the French navy, but in their arsenals, every preparation has been made for a desperate struggle on the ocean. The same difficulties which steam had introduced into our navy, must also have pervaded theirs; but it is significant that, notwithstanding the costly experiments made by this country, France should have recently possessed a fleet equal to, if not greater than our own, and one as perfect in all the scientific improvements of the period. Nor were the above the only serious causes of anxiety in the minds of the most experienced naval statesmen: for paddle ships were of necessity restrained within certain limitations as to the size of their masts and the quantity of sail available, inasmuch as beyond a certain amount of canvas, it was found that a ship under sail could in a breeze actually *overrun* the paddle, which at such times became an incumbrance; and further, with diminished masts and rigging, the reduction in a sailor's work aloft threatened to deprive England of her so long boasted advantage over other nations in the superior skill of her seamen, thus, indeed, threatening to reduce her to the level of other powers; but the success of the Rattler demonstrated, in 1845, that while the dominant superiority of the screw-propeller restored space for the broadside armament, it did more,—it renewed, in the full rig of a screw steamer, necessity for that experience and dauntless activity and proficiency in seamanship aloft which has been so universally acknowledged and eulogised as an attribute of a British sailor. Happily, therefore, the screw line-of-battle ship, or the screw frigate of the present day, when under sail with her funnel reefed, presents no peculiarity of rig, except the neatness peculiar to an English man-of-war.

This also obviates another difficulty which long embarrassed the naval affairs of the country. With a paddle fleet, having reduced masts, and therefore less able to fully avail themselves of a favourable wind, the expense, though large, bore but little proportion to the many other inconveniences attending the necessary supply of coals to ships in commission; whereas in a screw fleet the assistance offered by the wind is always available, and much less coal is required, for after all the screw is but an auxiliary, to be used only in adverse winds or calms, except under emergency; while it fortunately admits of being used with sailing power, because it has been proved that a screw propeller can always be made to increase the speed of a ship under sail, and should accident happen to the machinery, the screw can be lifted, so as to give full benefit to the vessel as a sailer.

Perhaps the most important advantage over the paddle introduced by the screw is, that whereas the machinery of a paddle ship unavoidably exposes her main shaft and cranks and connecting rods to an enemy's shot, from their necessary elevation above the centre of gravity of the floating mass, the machinery for the screw and its main shaft admit of being placed below the water-line, and close to the keelson; while, again, the necessity for finer lines and greater length of hull in a screw ship produce an additional space, which generally suffices for the engine and fuel, without any decrease of stowage for provisions and stores.

The success of the Rattler encouraged the construction of a fi screw frigate, the Arrogant, launched in 1848, mounting 46 gu and of the burden of 1872 tons. This ship may be said to the pioneer of a new system, as regards frigates, for in 1852 wa launched the Imperieuse, the first of a heavy class of frigates wh are now the pride of the service. This fine ship is armed, like successors, with 51 guns (50, and a pivot gun), and is of the burd of 2347 tons.

The year 1852 is also remarkable as being that in which the Leop the last (and it is supposed to be the *best*) of all our paddle steamers, wa brought into the service: and also because in that year the fir screw line-of-battle ship of two fighting decks was introduced, in the Agamemnon, the first of the 91's, being of 3074 tons, to correspo with which several of our three-deckers have since been cut down an similarly armed.

In the same year also the class of 21-gun corvettes, with one fi fighting deck, first made its appearance in the Highflyer, bein 1153 tons, and armed with 68's. The Scylla and others are of th class; but as war steamers the class will probably be allowed wear out.

The superior speed of steamers, and the regularity with wh voyages could be performed, threw upon the hands of the admiralty a large fleet of sailing-ships, the biggest of which in a calm wo scarcely be a match for a screw-corvette of the present time. Altho it must be borne in mind that the one important and only avail test of the value of a steam fleet had been happily withheld; althou the world has yet to learn the details and the horrors of an engage between steam fleets; the judicious, though gradual increase in th number of screw-propellers used in the navy, seems in a measure have cleared the political horizon of many threatenings and misgiv as to our continued superiority. The old English patriot again ma breathe freely when he contemplates the apparently full-rigged li of-battle ship, fitted with screw-propeller, and differing nothing appearance from the old "walls" on which his youthful gaze dw with confidence and pride.

Enough for our purpose has been said of the general events wh attach to the past of the naval force of Great Britain. We n consider its present condition, first presenting a condensed view o the forces of all the navies of the world, as compiled principally from Hans Busk's and other elaborate works on the subject, for the year 1859.

Conspectus of the Naval Forces of the World.

	Effective Ships of the Line.				Frigates.				Block Ships.	Mortar Ships.	Corvettes and Sloops.				Surveying and Small Vessels.				Gun Vessels.	Screw Steam Gun Boats.	Floating Batteries.	Tenders, &c.			Troop and Store Ships, Depôt, Training, and Gunnery Ships.				Yachts.			Grand Totals.
	Sailing.	Screw.	Paddle.	Total.	Sailing.	Screw.	Paddle.	Total.			Sailing.	Screw.	Paddle.	Total.	Sailing.	Screw.	Paddle.	Total.				Screw.	Paddle.	Total.	Sailing.	Screw.	Paddle.	Total.	Screw.	Paddle.	Total.	
England	15	36	..	51	16	19	9	44	9	4	72	47	24	143	23	3	24	50	26	161	8	4	38	42	25	13	2	40	1	4	5	583
France	11	40	..	51	40	38	19	101	..	..	18	20	..	38	82	..	67	149	8	20	8	..	..	..	26	47	..	73	..	..	..	583
						4 plated.																										
Russia	12	7	..	19	7	11	..	18	..	..	7	12	..	19	50	..	..	50	..	..	..	..	..	1	15	42	..	57	..	..	..	164
Sweden	5	3	..	8	5	1	..	6	..	8	13	3	..	16	..	..	..	241	..	11	..	..	..	..	..	..	..	21	..	..	..	311
Norway	..	..	..	..	2	2	..	4	..	..	3	2	..	5	..	..	..	11	121*	2	..	..	..	..	..	..	..	..	..	..	..	143
Denmark	4	..	..	4	6	3	..	9	..	..	4	3	..	7	..	..	..	13	..	67	..	..	..	..	..	..	..	20	..	..	..	120
United States	10	..	..	10	11	15	4	30	..	..	21	2	5	28	..	..	..	4	..	..	..	..	..	2	..	..	..	5	..	..	..	79
Holland	5	..	..	5	16	..	..	16	..	..	5	5	..	10	..	..	..	51	..	57	..	..	..	..	..	..	..	..	..	..	..	139
Belgium	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	7	..	..	..	..	..	..	..	..	..	..	..	..	..	7
Spain	2	..	..	2	4	3	3	10	..	..	4	..	..	4	..	..	..	56	..	..	..	..	..	..	..	..	..	10	..	..	..	82
Two Sicilies	2	..	..	2	5	14		19	..	10	2	..	4	6	..	..	..	41	..	40	..	..	..	..	..	..	..	3	..	..	..	121
Austria	..	1	..	1	4	3	..	7	..	1	5	2	..	7	..	..	..	96	..	16	..	..	..	..	..	..	..	7	..	..	..	135
Portugal	1	..	..	1	1	..	..	1	..	..	3	..	..	3	..	..	..	23	..	..	..	..	..	..	..	..	..	9	..	..	..	37
Sardinia	..	..	..	..	4	6	..	10	..	..	4	3	..	7	..	..	..	8	..	..	..	..	..	..	..	..	..	3	..	..	..	28
Prussia	..	..	..	..	2	2	..	4	..	..	1	1	1	3	..	..	..	4	..	42	..	..	..	..	..	..	..	1	..	..	1	55
Greece	..	..	..	..	2	1	..	3	..	..	..	..	..	..	..	..	..	13	4	4	..	..	..	..	..	..	..	1	..	..	1	26
Turkey	..	..	..	7	..	..	..	6	..	..	..	..	..	4	..	..	..	9	..	..	..	..	..	..	..	..	..	23	..	..	7	49
Brazil	..	..	..	..	..	..	..	1	..	..	..	..	..	5	..	..	..	19	..	2	..	..	..	..	..	..	..	..	..	..	..	27
Peru	..	..	..	..	..	..	..	2	..	..	..	..	..	2	..	..	..	11	..	..	..	..	..	..	..	..	..	..	..	..	..	15
Chili	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	5
Mexico	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	9	..	..	..	..	..	..	..	..	..	..	..	..	..	9
Totals	..	..	..	161	..	..	..	291	9	23	..	..	..	308	..	..	..	869	159	422	16	..	..	45	..	..	..	273	..	..	7	2583

The naval force of Great Britain, according to the Navy List of July, 1860, is as follows :—

	Ships.
In the effective list we have of all sizes and arms	572
Gun-boats, of which 59 are used as tenders, &c.	164
Ships and vessels in harbour service	125
Cutters, &c., used as coast-guard tenders	47
Total	908

The total number of 908 ships does not include Admiralty lighters, hoys, and various small craft employed in coasting and about the Royal Dockyards.

The number of seamen and marines voted for the navy in the se sion of 1860, was 84,100. In addition, a reserved volunteer force of seamen to the number of 30,000, was provided by the 22 & 23 Vic. cap. 40, passed in the session of 1859.

The engineers of the navy consist of 8 inspectors of machinery, of whom 5 are afloat; 139 chief engineers; 6 acting first-class in charge; 148 first-class assistants; 207 second-class; and 530 third class.

All mere abstracts regarding maritime forces must be defective unless the number of guns, weight of metal (distinguishing solid sh from shells), the speed of ships, the stowage, the steering qualities, spread of canvas, &c., be taken into consideration. The preceding tables will, however, show as accurately as necessary our relative position. Such diversities of build and equipment so much affect the specific numbers under each head, that at best we can only obtain general notions. The vagueness of the terms frigate and corvette must be remembered. We have now the elements of a magnificent navy,—one that will no longer be mistaken for a mere steam fleet depending on fuel. It has been during the past twenty years loudly and industriously circulated throughout Europe, with evident satisfaction to some of the nations of Christendom, that the glory of England was on the wane—that her prestige was gone—that steam had levelled her to the scale of other countries possessed of coal and iron, and that steam had bridged over the Channel. But a sight of the above tables ought to induce a belief that the sovereignty of the seas is still in our hands.

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* Row-boats.

The following tables show the armament, and the nature of special services employed on:—

1. THE EFFECTIVE LIST.

STEAM SCREW.

		Guns.
4	floating batteries of	16
4	,, ,, .	14
7	coast-guard ships .	60
2	,, ,, .	80
1	,, ,, .	31
13	gun vessels . .	5
6	,, . .	4
1	,, . . .	2
5	,, . .	1
8	store ships.	
1	tender.	
3	mortar vessels.	
1	particular service.	
3	troop ships.	
2	tanks.	
2	surveying vessels.	
1	screw and paddle, "Bee."	
1	screw factory.	
4	ships . . .	131
4	,, . . .	121
3	,, . . .	101
1	,, . . .	100
12	,, . . .	91
15	,, . . .	90
2	,, . . .	86
1	,, . . .	81
8	,, . . .	80
1	,, . . .	70
2	,, . . .	60
20	,, . . .	51
1	,, . . .	50
1	,, . . .	47
1	,, . . .	40
1	,, . . .	36
2	,, . . .	32
2	,, . . .	31
2	,, . . .	26
1	,, . . .	25
3	,, . . .	22
13	,, . . .	21
2	,, . . .	20
11	,, . . .	17
2	,, . . .	16
1	,, . . .	15
1	,, . . .	14
3	,, . . .	13
2	,, . . .	12
4	,, . . .	11
4	,, . . .	9
3	,, . . .	8
8	,, . . .	6
15	,, . . .	4
1	,, . . .	3
222	Total.	

PADDLE.

21	tenders.
6	tugs.
1	surveying.
4	particular service.
1	vessel of 28 guns.
1	,, 22 ,,
1	,, 21 ,,
1	,, 18 ,,
5	,, 16 ,,
36	,, 6 ,,
3	,, 5 ,,
4	,, 4 ,,
12	,, 3 ,,
5	,, 2 ,,
1	,, 1 ,,
6	,, 0 ,,
108	Total.

BUILDING.

1	of 101 guns
10	,, 91 ,,
8	,, 51 ,,
2	,, 36 ,,
3	,, 21 ,,
4	,, 17 ,,
1	,, 16 ,,
6	,, 11 ,,
4	,, 5 ,,
4	,, 4 ,,
43	Total.

SAILING.

18	tenders.
4	surveying ships.
8	store ships.
3	receiving ships.
2	hospital ships.
1	lent to Mercantile Marine Association, Liverpool.
2	gunnery ships.
1	emigration hospital ship.
1	coal depôt.
1	discovery ship.
1	ship of 120 guns.
4	,, 104 ,,
1	,, 101 ,,
10	,, 84 ,,
3	,, 80 ,,
4	,, 78 ,,
6	,, 72 ,,
2	,, 70 ,,
19	,, 50 ,,
8	,, 44 ,,
18	,, 42 ,,
5	,, 40 ,,
2	,, 36 ,,
1	,, 28 ,,
1	,, 27 ,,
11	,, 26 ,,
3	,, 24 ,,
1	,, 22 ,,
2	,, 20 ,,
1	,, 19 ,,
5	,, 18 ,,
8	,, 16 ,,
5	,, 14 ,,
17	,, 12 ,,
5	,, 8 ,,
3	,, 6 ,,
2	,, 4 ,,
3	,, 3 ,,
2	,, 2 ,,
3	,, 0 ,,
197	
1	reserve depôt ship.
1	ordinary depôt.
199	Total.

2. THE HARBOUR SERVICE.

Ships.	
27	used as coastguard and watch vessels.
25	,, coal depôts.
6	,, quarantine hulks.
2	,, hospital ships.
2	,, powder depôts.
20	,, receiving hulks.
2	,, tenders.
2	,, mooring vessels.
9	,, convict hulks.
4	,, churches.
2	,, breakwaters.
3	,, police vessels.
3	,, sheer hulks.
2	,, juvenile reformatories.

Ships.	
1	used as anchor hoy.
1	,, school ship.
2	,, tanks for supplying water.
1	,, light vessel.
1	,, guard ship.
1	,, moving lighter.
1	,, engineer's fitting vessel afloat.
1	lent to Marine Society.
118	employed.
7	hulks.
125	

It has been the practice in the British navy to dismantle ships when out of commission, and to keep them in the state of hulks until their services were again required.

A ship is called into active service, or "commissioned," by the appointment of a captain or commander to her, and his pendant being hoisted to announce the fact of her being placed under the Articles of War, she was taken to an appointed dockyard for refitting, manning, arming, &c., and in the course of a few weeks reported ready for sea. Hence, when sudden emergency arose, considerable delay in refitment postponed the time at which the services of the ship could be available to the country.

In 1844, however, the Firebrand, paddle-steamer, being out of commission at Portsmouth, was advanced so as to be considered a "reserve" ship. Gradually from that period, but by very slow and unequal steps, what is now called a *steam reserve* had been increasing, until in 1856 such reserve became a most valuable system, and extended from Portsmouth to Plymouth and Sheerness. As our ships of war are altered for steam-power, they, as well as new ships, are placed in the nearest steam-reserve. In this reserve force the effective unemployed ships are arranged as under, in four divisions:—

The first division consists of such ships, of every class, as are ready for sea within a day or two after being commissioned, so far as masts and rigging and all fittings are concerned, including guns, anchors, cables, shot, tanks, &c., together with all machinery, which in trial trips and periodical examinations by an inspector of machinery afloat has been properly tested and duly reported on, through the captain of the steam reserve, and from him to the commander-in-chief and the Admiralty. But powder and provisions are only shipped when about to proceed to sea.

The second division consists of such ships of every class as are fitted with engines, anchors, cables, shot, and tanks, but have neither masts, guns, powder, nor provisions on board. These will also have been tested in trial trips.

The third division comprises ships of any class which have their engines on board, but are without masts, guns, shot, tanks, anchors and cables, powder or provisions.

The fourth division are those ships which are in mere "ordinary," being in various stages of incipient preparation for advancement.

Not only does this arrangement provide ships to meet the sudden demands of diplomacy, but it affords a reserve of available subordinate officers for immediate sea service. In no branch of usefulness is this of more importance than as regards officers of engineers and warrant officers, who are attached to the guard-ship of each steam-reserve, and are subservient to all the discipline and usages of the service. Much remains to be done and is in progress, such as the providing means for the training of young engineers of the reserve, and also of boys who enter the navy; so that instead of sending raw recruits into the seagoing ships, boys are sent who, after about a year's training in the reserve school-ship, are fit to commence the career of a British sailor as "first-class boys." At present Sheerness is the only reserve port at which the educational movement has been tried on a large scale. The school-ship at that port is considered a model and an example for imitation. The long-wanted means for enabling young engineer officers to prepare for their examinations, has been here met with abundant advantage to them and to the service. There is also in the ship a school for the education of the children of engineers and warrant-officers of the steam reserve.

The government of the navy is vested in the lord high admiral, which office has been in commission since the Revolution, with the exception of two short periods, 1707-8 and 1827-8, when it was held respectively by Prince George of Denmark and the Duke of Clarence, afterwards King William IV. At present the Board consists of a first lord, who is a member of the cabinet, and five junior lords. By their orders all ships are built, sold, or broken up, commissioned, employed, and paid off. All appointments and promotions are made or approved by them; all honours, pensions, and gratuities are granted on their recommendation. All orders for the payment of naval moneys are made by them; they prepare the navy estimates, and lay them before parliament. The civil departments of the Admiralty are directed by the surveyor of the navy, accountant-general, storekeeper-general, comptroller of victualling, and physician-general.

The navy is composed of two bodies of men—seamen and marines.

There are commissioned, warrant, and petty officers.

The commissioned officers are flag-officers, captains, commanders and lieutenants.

Flag-officers are divided into the following classes, and rank and command in the order here following:—

Admirals of the fleet.

Admirals of the red, white, and blue squadrons.

Vice-admirals of the red, white, and blue squadrons.

Rear-admirals of the red, white, and blue squadrons.

There are superannuated and retired rear-admirals, who enjoy the rank and pay, but do not rise.

The admiral of the fleet, when in command, bears the union flag at the main-top-gallant-mast. The other flag-officers bear a square flag of the colour of their squadron at the main, fore, or mizen top-gallant-mast, according to their rank.

The flag-officer holding the chief command of a fleet or squadron employed within certain geographical limits, termed a station, is called a commander-in-chief. He is responsible for the efficiency and conduct of the fleet under his orders; he disposes of the vessels composing it in such manner as will be most advantageous for the service; but without some especial necessity he is never to send one beyond the limits of his station. All vacancies in ships under his orders which are caused by death or dismissal from the service by the sentence of a court-martial, are in his gift.

A temporary rank is given to captains called commodore: they are of two classes, the first class having the pay and allowance of a rear-admiral, with a captain under him. They bear a broad pendant, but must strike it in the presence of a senior captain. Captains and commanders are appointed to command her Majesty's ships, except when the latter are appointed to flag-ships and ships of the line, in which case they must have served three years in command of a sloop or as first lieutenant of a rated ship.

When a captain or commander is ordered to commission a ship, he does so by hoisting a long pendant, having a St. George's cross on a white field next the mast, and a fly of the colour of the admiral's flag under whose orders he is placed. No vessels, except such as belong to her Majesty, or are hired for her service, and commanded by a naval officer, are entitled to wear this pendant. The ship being commissioned, a hulk or receiving ship is allotted for the use of the crew while fitting for sea; a party of marines, commanded in rated ships by a commissioned officer, is sent on board; seamen are entered as they volunteer, on being reported fit for the service after examination by the surgeon; stores are demanded as required, and the sea-stores, provisions, and water stowed away. When ready for sea, the ordnance and powder are received on board; the crew are paid two months' wages in advance; and the ship only waits the sailing orders from the Admiralty to proceed to her destination. The duty of the captain as regards the books and accounts is regulated by Act of Parliament; but the interior arrangements and discipline depend mainly on himself, in which he has for his guidance the Act 22 Geo. II., called the Articles of War, and the general printed instructions issued by the Admiralty. All muster and pay books, &c., are signed by the captain, commander, or senior lieutenant, master, and purser, or other officer in whose charge the stores in question may be placed.

The senior lieutenant is nominated by the captain, and has under his direction the whole management and superintendence of the internal arrangements of the ship; indeed on the qualifications of this officer must in a great measure depend the state of discipline and efficiency. The other lieutenants take the watch by turns, during which time they have charge and command of the ship; they are never to quit the deck without being relieved. The watches are periods of four hours, except that from four to eight P.M., which is divided into two, called the dog-watches. No mate is eligible for the rank of lieutenant until he has served six complete years in the navy, has completed his nineteenth year, and passed in seamanship and navigation.

The master has charge and stowage of the holds; a general charge of stores and store-rooms, over the gunner, boatswain, and carpenter; and navigates the ship under the directions of the captain. Secretaries are appointed by the flag-officer whom they serve.

Chaplains must be in priest's orders of the Church of England.

The paymaster has charge of the provisions, and the issuing of them, also of the slop clothing, soap, and tobacco; he enters into a penal bond with sureties for the honest discharge of his duties.

Mates are midshipmen who have passed the examination qualifying them for the rank of lieutenant.

Gunners, boatswains, and carpenters must have served a complete year as petty officers before they can be promoted. The gunner has charge of all ordnance stores; the boatswain, of all the sails, rope, and rigging; the carpenter, of all stores in his department, and is also to see the ports secure and water-tight, and to sound the well daily, and have the pumps in order for service. [GUNNER, NAVAL; BOATSWAIN; WARRANT OFFICERS, &c.]

In the event of the command of a ship devolving on petty officers, they are to take rank and command as they stand in the table of pay, except the following, who are not to take command:—

Schoolmasters,	Masters-at-arms,
Clerks,	Ships'-corporals.

Midshipmen cannot enter under twelve years of age nor above fifteen; they are appointed by the Admiralty. They have no specific duties.

By an Admiralty order, 23rd Feb., 1857, young gentlemen can enter the Royal Navy, as naval cadets, between the ages of thirteen and fifteen, being required to pass a previous examination at the Royal College, Portsmouth. After eighteen months' study they are eligible for promotion as midshipmen on passing another examination. A midshipman of eighteen months' standing has again to pass examination at the College, and if successful, he is eligible, after two years further service as midshipman, to the rank of mate.

All commissioned officers below a captain, midshipmen, also naval cadets, and schoolmasters, must pass the requisite examinations to qualify them for their respective posts.

Petty officers are rated as far as possible from the leading seamen. They are ranged into classes thus—

Chief petty officers, who wear as a badge on the arm	The crown and anchor encircled with laurel.
First-class working petty officers, ditto	Crown and crossed anchors.
Second ditto ditto	Crown and anchor.
Leading seamen wear . . .	Anchor.

N.B.—Seamen are also allowed increased pay for continued [illegible] conduct, and wear chevrons of gold lace on the arm, according to merit.

The enlistment of boys has recently undergone a change [illegible] beneficial to the service. Second-class boys are entered for continuous service for ten years, but only with consent of parents or guardians.

The following abstract shows the daily allowance of provisions to every person in the fleet:—

Fresh meat, 1 lb.	Soft bread, 1½ lb.
Vegetables, ½ lb.	Rum ½ gill.

When the above are not issued, the following:—

Salt beef, ¾ lb. and Flour, ¾ lb.	alternately	Salt pork, ¾ lb. and Pease, ½ pint.
Biscuit, 1¼ lb.		
Cocoa, 1 oz.	Vinegar, ½ pint	weekly.
Tea, ¼ oz.	Oatmeal, ½ pint	
Sugar, 1½ oz.		

A portion of the flour may be exchanged for a proportion of [illegible] and raisins; and after 14 days at sea on salt provisions, lemon-juice is allowed in addition.

The pay of officers and seamen has recently undergone some modifications, but as it is stated that further alterations, to the advantage of every class, are still in contemplation, we refer for the present to the 'Navy List,' published periodically, where the actual scale is given in full detail. In a supplement to the 'London Gazette' of Friday, August 3, were issued the following regulations in reference to retiring pensions:—

All captains who have attained, or shall hereafter attain the age of sixty, without having served in their present rank, to be placed on a retired list, and receive retired pay as follows:—

If on 10*s.* 6*d.* half-pay list when retired,	18*s.* per diem.
If on 12*s.* 6*d.* ,, ,,	20*s.* ,,
If on 14*s.* 6*d.* ,, ,,	

Captains who may arrive at the head of the list, without having served in that rank, to be placed on the list of reserved flag officers with the pay of 23*s.* per diem.

Captains now on the 14*s.* 6*d.* half-pay list not to be affected by these arrangements unless by their own desire.

All commanders on the active list who have attained the age of sixty, or who may hereafter attain that age, to be placed on a retired list, with the rank and title of retired captain, and to receive half-pay according to their length of sea service on the scale hereinafter mentioned.

Total sea service in the rank of— Commander and Lieutenant.	Pay per diem.
Under 9 years	Half-pay they may be receiving at the time when retired.
Above 9 years' and less than 12 years' service . .	10*s.* 6*d.*
Above 12 years' and less than 15 years' service . .	12*s.* 6*d.*
Above 15 years' and less than 20 years' service . .	14*s.* 6*d.*
Above 20 years' service	16*s.* 6*d.*

Lieutenants on the active list, who have attained, or who may hereafter attain, the age of sixty, to be placed on a retired list with the rank of retired commander, and to receive pay according to their sea service.

Total sea service in the rank of— Lieutenant.	Pay per diem.
Under 6 years	Half-pay they may be receiving at the time when retired.
Above 6 years' and less than 9 years' service . . .	7*s.* 0*d.*
Above 9 years' and less than 12 years' service . .	8*s.* 6*d.*
Above 12 years' and less than 15 years' service . .	10*s.* 0*d.*
Above 15 years'	11*s.* 6*d.*

Time served in command of revenue vessels to count as sea time.

Time served in the coast-guard on shore, or in the transport service on shore, to count as sea time in the scale of retired pay, in the proportion of three years in the coast-guard, or transport service, as one of sea service.

Time served as mail or transport agents afloat, or abroad, to count for the same purpose as sea time for the first three years, and after then in the proportion of three years' agent's time as two of sea service.

For every year's service as acting lieutenant, mate, or passed midshipman, after the completion of two years' service or combined service in those ranks, an officer to be allowed 3*d.* per diem additional.

Greenwich Out-pensions.—All officers on the active list who accept the out-pension of Greenwich Hospital to be placed on the retired list of the rank which they may hold; and to be permitted to assume a step in rank on reaching the age of sixty, but without further increase of pay.

1. All officers retired under this scheme to be eligible for the out-pension of Greenwich Hospital for the rank that they held on the active list, provided that they shall have served the following periods of commissioned time afloat:—

Captains, 15 years, including time as commanders and lieutenants.
Commanders, 12 years, including time as lieutenants.
Lieutenants, 9 years in that rank.

2. Officers who have received, or who may hereafter receive, severe wounds in action, or disabling hurts on actual service, are to be exempt from the above rule respecting time of service.

3. Officers on the existing reserved and retired lists or captains or commanders to be eligible for the out-pension of Greenwich Hospital, on the conditions stated in articles 1 and 2 of this section.

4. The regulations laid down in the scheme of retirement respecting time served in the coast-guard, transport, or mail service, to apply to the time required to be served for Greenwich out-pension.

The following pensions will be allowed to the widows of officers retired under this scheme, namely:—

1. Captains of 3 years' standing and upwards	90*l.* a year.
2. Captains under 3 years' standing	80*l.* ,,
3. Commanders retired with the rank of captain	75*l.* ,,
4. Lieutenants raised to the rank of commander	60*l.* ,,

We will now turn to that noble establishment and asylum for worn-out and disabled seamen, Greenwich Hospital. The revenue of the hospital is about 150,000*l.* a-year. The establishment consists of a governor, lieutenant-governor (both flag-officers), four captains, and eight lieutenants, residing in the hospital. There are about 2710 in-pensioners, and 120 matrons and nurses, all of whom must be seamen's widows.

There are two schools at Greenwich, called the Upper and Lower Schools.

The Upper School comprises two classes:—

1st. One hundred sons of commissioned and ward-room officers of the Royal Navy and marines.

2nd. Three hundred sons of officers of the above or inferior rank, and of private seamen and marines who have served or are serving her Majesty, and of officers and seamen of the merchant service.

They are admitted from ten to eleven years of age, under certain regulations, and are subject to the same discipline, diet, education, clothing, and destination. At the age of fifteen, or sooner, if the course of education be completed, they are sent to sea in the queen's or merchant service, or otherwise disposed of.

The Lower School consists of 400 boys, the children of warrant and petty officers, seamen and non-commissioned officers and privates of marines, who have served or are serving, or have lost their lives in the service of her Majesty. They are admitted from nine to eleven years of age, and quit at fifteen, the boy being sent to sea; any unprovided for at fifteen are sent to their parents or guardians. Any boy may be removed from this to the Upper School on obtaining a presentation, if not more than eleven years old, and possessing character and abilities.

Prizes taken by naval officers are the property of the captors, according to a certain scale, varying with the rank. There are ten classes of which second-class boys are the lowest, having only one share, and flag-officers the highest.

When any of her Majesty's ships carries bullion or jewels or freight, the captain or commander is allowed a per centage, regulated by the queen in council, as compensation for the risk and charge, one-fourth part of which is given to Greenwich Hospital, one-fourth part to the commander-in-chief if he shares the responsibility, and the other half to the captain.

Officers settling in the Australian colonies are allowed a remission of the purchase-money, in amount from 100*l.* to 300*l.*, according to their rank and length of service.

NAZARENES. It appears from many parts of the New Testament, that the majority of the Jewish converts to Christianity continued to observe the precepts and ceremonies of the Mosaic law. The destruction of Jerusalem by Titus was the cause of many of the Jewish Christians laying aside their peculiar customs; and from this time those Christians who continued to preserve the Mosaic law appear to have received the name of Nazarenes and Ebionites. [EBIONITES.] These two sects, though frequently confounded, differed in many essential particulars; the Ebionites held many erroneous opinions on some of the leading doctrines of the Christian faith, while the former only differed from the orthodox in maintaining that Jewish Christians were bound to observe the Mosaic law as well as the precepts and commandments of the Christian religion. The early fathers do not appear to have regarded the Nazarenes as heretics, indeed the name was applied commonly to all the disciples of Christ. This may be the reason why we find no mention of them till the fourth century, when they are named, for the first time, by Epiphanius, and when it is asserted they have some peculiar opinions as to the divinity of Christ. On the gospel of the Nazarenes, see GOSPEL.

(Burton's *Lectures on the Ecclesiastical History of the Second and Third Centuries*; Mosheim's *Ecclesiastical History*, vol. i.)

NE EXEAT REGNO, is a writ which issues out of Chancery on the application of a complainant, to prevent his debtor from leaving the realm, being, in short, the *capias* of the Court of Chancery. It is directed to the sheriff of the county in which the debtor is; and commands him to cause the debtor to give sufficient bail or security, in the sum of——*l.*, that he will not go, or attempt to go, into parts beyond the seas, without leave of the court; and in case he shall refuse, to commit him to prison until he shall do it of his own accord, &c.

The writ cannot be applied for unless in a suit, that is, unless a bill is already filed; but a plaintiff may apply for it in any stage of a suit, whether the writ is prayed for by the bill or not. There must be a *debt in equity* actually due at the time when the writ is applied for; for the writ is not obtainable for a demand on which a party can be held to bail at law. The affidavit must also show that the defendant is going abroad, or it must show facts which prove that conclusion, and that the debt will be in danger if he quit the realm. The writ may be moved for *ex parte*, and issues until answer or further order. A defendant may apply to discharge the writ on putting in his answer.

This writ is founded on the real or supposed prerogative of the king to restrain his subjects from departing from the realm. The "Natura Brevium" contains two forms of writs, one of which has for its object to restrain a clergyman from going abroad without the king's licence; and commands the sheriff to take security from him or commit him to prison; the other has for its object to prevent a layman from going abroad without the king's licence; but it requires no security from the party, and differs in several other respects from the other writ. These writs are both entitled De Securitate Invenienda, &c, and seem to be in substance, though not in name, writs of Ne Exeat Regno. From the former the present writ seems to be derived.

It is said that the object of the writ, as applied to clergymen, was to prevent them from having frequent intercourse with the Papal see. Whether the prerogative on which these writs were founded was a usurpation on the part of the crown or not, is a matter which has been somewhat discussed. The opinion that such a power as that which is exercised by this writ, "appears to have been unknown to the ancient common law, which, in the freedom of its spirit, allowed every man to depart the realm at his own pleasure" (Beames), is a vague surmise, expressed in language equally vague.

(*A Brief View of the Writ Ne Exeat Regno* by Beames.)

NEAP TIDES. [TIDES.]

NEBULÆ. A class of objects in the sidereal heavens, distinguishable by a dim light and the absence of any definite outline. The earliest notice of nebulæ is to be found in the 'Syntaxis' of Ptolemy, who has inserted five objects in his catalogue under the appellation of *cloudy stars*. The application of the telescope to astronomical observation revealed the real nature of the earlier nebulæ. It was found that in every instance they really consisted of an aggregate number of stars, apparently so close to each other that they failed to produce an impression of their individual existence upon the eye. In 1614, Simon Marius discovered a nebula in the constellation Andromeda, which seemed to be of a totally different nature to any of the nebulæ hitherto discovered, inasmuch as when observed in the telescope it was found to be irresolvible into stars. Its discoverer compared the aspect presented by it to that exhibited by the light of a candle when viewed through a transparent horn. In 1618 a similar object was discovered in the constellation Orion, by Cyzatus, a Swiss astronomer. Huyghens, who recognised this nebula in 1656, without having been aware of its previous discovery, was struck with amazement at its singular aspect. The region in the vicinity of the nebula being intensely black, he conceived that the phenomenon was occasioned by looking through an aperture in the heavens into the luminous region beyond.

About the middle of the last century, the number of nebulæ discovered by astronomers amounted to little more than twenty. In 1755, Lacaille, the French astronomer, announced to the Academy of Sciences the existence of 42 additional nebulæ in the southern hemisphere. He divided them into three distinct classes. The first class comprised those objects which, when viewed in the telescope, were found to retain their nebulous aspect without affording any indication of sidereal structure. The second class consisted of such nebulæ as were resolvable by the telescope into stars. The third class consisted of stars surrounded by a nebulous substance. Messier, another French astronomer, was the discoverer of no fewer than 103 new nebulæ. His observations are recorded in the 'Memoirs of the Academy of Sciences' for 1771, and in the volumes of the 'Connaissance des Temps' for 1783 and 1784.

The elder Herschel was the next astronomer who contributed towards the existing knowledge respecting nebulæ. In 1786 he communicated to the Royal Society a catalogue of 1000 new nebulæ. This was followed by a second catalogue, communicated to the same Society in

1789, and containing 1000 additional nebulæ. In 1802, he communicated a third catalogue of nebulæ, containing 500 new objects. On this last occasion he distributes the various objects of the stellar regions into twelve distinct classes.

I. *Insulated stars*, such as Arcturus, Capella, Sirius, &c.

II. *Binary stars*, or in other words, systems of two stars revolving in each case about their common centre of gravity.

III. *Triple and Multiple stars.*

IV. *Clustering collections and the Milky Way.* Herschel was of opinion that in many parts of the heavens the stars afford indications of collecting together and forming distinct clusters from the effect of their mutual attraction. He supposes that the Milky Way is undergoing a process of disruption from this cause.

V. *Groups of stars.* This consisted of aggregrations of stars which did not exhibit any regularity of outline, nor condensation in any part of their structure indicative of their forming separate systems.

VI. *Clusters of stars.*—These were objects of a round form, presenting in all cases a gradual condensation towards the centre.

VII. *Nebulæ.*—These were supposed to be objects consisting in reality of aggregate collections of stars.

VIII. *Stellar nebulæ.*—These were imagined by Herschel to be clusters of stars situate at such immense distances as to put on the aspect of merely luminous points with burs.

IX. *Milky nebulosity.* This class consisted partly of aggregate collections of stars which were nebulous only in appearance, and partly of objects of a purely nebulous substance, like the nebula of Orion.

X. *Nebulous stars.*—These were stars surrounded by a nebulous atmosphere.

XI. *Planetary nebulæ.*—This class consisted of nebulæ of a perfectly round form, exhibiting a resemblance to the planetary bodies of the solar system, only they shone by a very pale light.

XII. *Planetary nebulæ with centres.*—The aspect exhibited by these objects suggested the idea of a gradual condensation of the nebula into a single luminous point.

In 1811, Herschel communicated to the Royal Society a paper, in which he explained his views of the transformation of nebulæ into stars. He endeavoured to prove that the nebulous substance, which his observations indicated to be extensively diffused throughout the sidereal universe, had a tendency to form into distinct aggregations of matter, in consequence of the mutual attraction of its particles, and that the resulting mass in each case by a process of gradual condensation finally acquired the consistency of a solid body. More recent observations of nebulæ have not served to confirm this bold hypothesis.

In 1833, the younger Herschel communicated to the Royal Society a paper, containing the results of a re-observation of the nebulæ of the northern hemisphere. These results are embodied in a catalogue containing 2306 nebulæ and clusters, of which about 500 were discovered by himself. In 1828, Mr. Dunlop communicated to the Royal Society a catalogue of 629 nebulæ and clusters observed in the southern hemisphere; and in 1847, the younger Herschel published the results of his astronomical observations at the Cape of Good Hope which, besides various other objects of importance, contained a catalogue of 1708 nebulæ and clusters observed in the southern hemisphere.

The most recent contribution to nebular astronomy is due to Lord Rosse, who in 1850 communicated to the Royal Society a paper, containing the results of observations made by him, chiefly with his celebrated six foot reflector. One of the most remarkable facts disclosed by these observations consists in the spiral arrangement of several of the objects. It appears also from them, that many nebulæ which had been previously considered as irresolvible objects, consist of agglomerations of stars, and the conclusion naturally suggested by such observations is, that all nebulæ are in reality nothing more than aggregate masses of stars, which merely require telescopes of adequate power to reveal their true structure.

NECESSITY. [FREE WILL.]

NECRO'SIS (from νεκρός, "dead,") is the term applied particularly to mortification or death of bone. Its general causes and the mode of reparation are the same as those of mortification generally. [MORTIFICATION; INFLAMMATION; BONE.]

NEEDLE MANUFACTURE. This branch of industry is supposed to have originated in Spain, from the circumstance of the name *Spanish needles* being originally used in England, although the art was brought here from Germany. Needles were first made in England about the year 1565, by Elias Crowse or Krauso, a German, who settled in London; or, as others say, by a Spanish negro, who refused to reveal the secrets of his art. The manufacture was lost to England for nearly a century, but recovered about 1650, by Christopher Greening, who settled at Long Crendon in Buckinghamshire. The reputation long enjoyed by *Whitechapel* needles points out the particular locality in London where the manufacture was once carried on. At the present time, the largest numbers of needles are made at Redditch in Worcestershire, at Hathersage in Derbyshire, and in and near Birmingham.

The manufacturing processes are as follows:—The steel is procured from the Sheffield or Birmingham wire-drawers, in coils of 12 lb. or 14 lb. of wire. The usual sizes of sewing needles vary from $\frac{1}{22}$ to $\frac{1}{100}$ of an inch, and the wire is selected of corresponding thickness. The wire is cut into lengths equal to two needles; and these lengths, being placed together in a bundle, are brought to a glowing heat, and bound together by means of iron rings from three to seven inches in diameter, placed at each end of the bundle. This bundle is then placed on a cast-iron table, and rolled to and fro upon it, under the pressure of a flat bar of iron, by which means the wires are made perfectly straight. Several of these wires are then taken by the grinder, and together are pointed on a small dry grindstone. This process requires considerable dexterity for its proper accomplishment, as each wire must be so held by the grinder as to revolve in contact with the grindstone. It is this dry-grinding which makes the trade of a needle-grinder so injurious to health, through the inhaling of the small particles of steel which are thrown off during the operation. A preservative against this evil has been provided: this consists of a mask of magnetic wire-gauze, worn so as to protect the mouth: the particles of metal, being attracted by this means, are prevented from passing into the lungs. It is but seldom however that the grinders can be induced to wear these masks. Needle-grinding is a well-paid but destructive employment; some men can grind 10,000 in an hour.

When the pointing (at both ends) is finished, the holes or eyes are perforated. This operation (on the hand method) is usually performed by females. The tools employed are, a small anvil fixed on the work-bench, a hammer, a finely-pointed and well-tempered steel punch, a pair of plyers, a file, and a block of lead. The woman makes an indentation on one side by means of the punch and hammer; the needle is then taken from the anvil, and being placed with the indented side downwards on the block of lead, the perforation is completed by striking with the punch and hammer on the opposite side of the needle. Holding then the needle in the plyers, the head is somewhat bent and with the file the *guttering* is performed, which is the forming of the channel that may be seen on each side where the perforation is made. The head is then smoothed by passing the file over it. Needles to which the name drilled-eyed is applied are perforated in the manner here described, but the additional process is used of smoothing the eye by means of a drill after it is perforated. In this hand method, the wire is cut into two before the perforating, and the end of each piece is slightly flattened with a hammer before the punch and drill are employed.

Machines, however, at first used for large needles, are now generally used for all sizes. The wires, each about three inches long if to form needles known as No. 6, are subjected to a stamping machine, in which a weight of 30 lbs. is brought down to stamp the gutter on each side of the needle, and to make an indentation partly through the wire; this is done at the rate of 4000 wires in an hour. A small hand-press, worked by boys, then drives each indentation right through the wire, thus making perforations for the eyes of two needles. In *fig.* 1, *b* is the double needle, resting on the anvil *a*, held in its place by *d*, and pierced by *c*. The wires are then "spitted;" that is, two fine wires are made to pass through the two eyes of several dozens of them, to hold them while a man files off the burr left by the stamping. The workman then bends and works the comb of wires to and fro between his hands, until he breaks each wire into two, leaving an eye or perforation to each half. *Fig.* 3 shows five different stages of the needle, up to the point where the wire is just about to be severed into two and magnified representations of the last three of those stages. The filer and two spitters prepare 4000 needles in an hour.

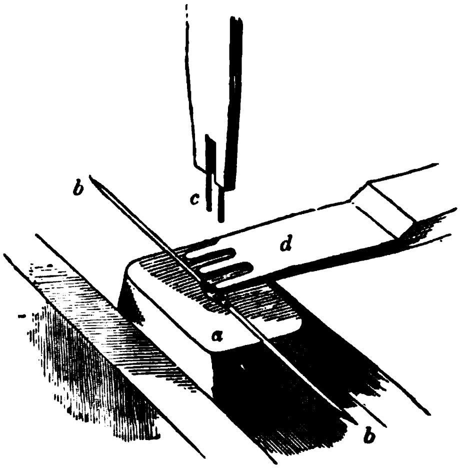

Fig. 1.—Piercing Needles.

These operations being performed when the steel wires are in a soft state, the wires become more or less bent, and must be straightened, which is done by rolling them on one plate of metal by a smaller plate dexterously handled; this is called *soft-straightening*. The needles are then placed, many thousands together, in a kind of crucible, and covered over with ashes; after which they are put into a close furnace and exposed to a cherry-red heat. When this degree of heat has been attained, the crucible is withdrawn, and the needles are dropped into cold water or oil; from this they are taken out and put upon an iron plate almost red hot, where they are turned about so as to cause the heat to apply equally to all; and as fast as the needles become of a blue colour, they are removed as being of a proper temper.

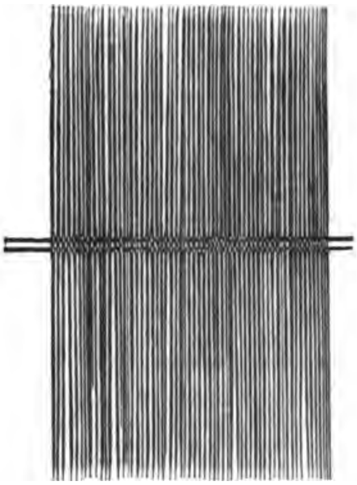
Fig. 2.—A Comb of double-needle wires.

Such of the needles as now appear crooked are straightened on a small anvil by blows from a hammer: a process conducted by women, and called *hammer-straightening*.

The needles are next ranged in parallel rows upon a coarse cloth, which has been smeared with a mixture of oil, soft soap, and fine emery powder. In this cloth from 40,000 to 50,000 needles are rolled up, and twenty or thirty of these rolls are placed together in a machine like a mangle. The rolling to which they are here subjected is continued, by means of steam or water power, for two and sometimes three days, during which time the cloth wrappers being worn out, require to be once or twice replaced by new ones. The finest needles require forty hours of this kind of friction. When taken out, after rolling, the needles are perfectly bright.

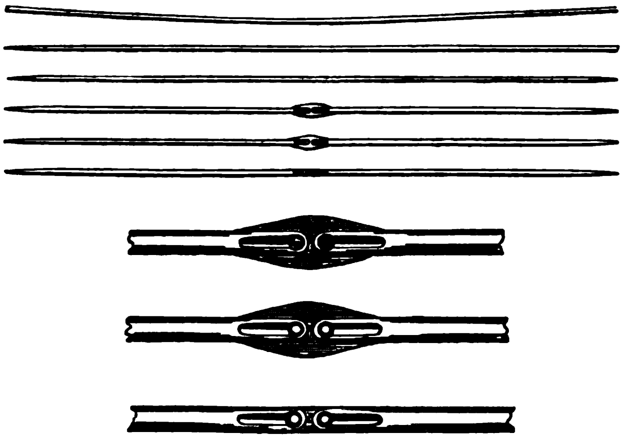
Fig. 3.—Successive stages of a Needle.

The excellence of modern needles consists, in part, in the process of *drilling*, to which the best kinds are subjected. When the eyes of needles are only stamped and pierced, their edges are apt to cut the thread; but by a subsequent drilling, the eye becomes as smooth and polished as any other part. To effect this, the needles are *blued*, or heated to a particular temper; then *countersunk*, to bevel the edges of the eye; then *drilled* by means of delicate wires which pass through the eyes; then *ground* on small revolving gritstones, to give roundness to the head of each needle; and then *polished* by pressure against revolving wooden wheels covered with buff-leather, and touched with polishing paste. The different stages in these highly-finished needles are shown in *fig.* 4.

The needles, whether of the finer or commoner kinds, are now examined for the rejection of any that may be imperfect; and then shaken in a flat tray until all become parallel. But, though parallel, they are not regular; seeing that the heads of some are in one direction, and those of others in another. They are brought into regularity in a simple but remarkable way. A girl, seated at a window, spreads out the needles before her, parallel with the window; by a delicate touch, aided by a quick eye, she draws out laterally to the right, those which have their eyes on the right, and to the left, those which have their eyes on the left; and then combines the two parcels. Women then separate the needles into parcels of 25, and wrap them up in blue papers—at the rate of 3000 needles in an hour. Labels are pasted on the papers and dried; 20 papers are packed into a parcel; and from 10 to 50 parcels are made up into a bundle, for the wholesale trade. If for exportation, the bundles are placed in soldered tin boxes. A bundle of 10,000 needles, of the kind called No. 6, forms a compact mass 6 inches long, 3½ wide, and 2 in thickness.

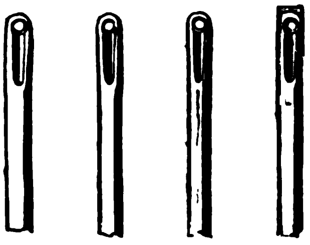
Fig. 4.—Drilled-eyed Needles.

Redditch, which was only a village a few years ago, is now a considerable town, almost all the inhabitants of which live by the needle trade. Eight or ten thousand persons are employed in the works in the town and neighbourhood; and these support the bulk of the remaining part of the population. The work is conducted on two different systems, the factory and the domestic. On the factory system a large building is constructed, supplied with steam or water power, and with efficient machines of all kinds; and in this building all the processes are conducted. On the domestic system, country people, living within a few miles of Redditch on all sides, come to the warehouses or manufactories in the town, fetch away a packet of wires or needles, take it home, do a portion of the work, and return the packets to the warehouses. Some do the annealing, some the pointing, some the piercing, some the drilling, &c.; each person, (of whom more than half are females) being competent for only one branch of the manufacture. The product of the whole neighbourhood, even several years ago, was supposed to reach 100,000,000 needles per week!

NEGATIVE QUANTITIES. This subject is considered, as a part of the most complete algebra, in the article ALGEBRA. In the present article we confine ourselves to such a view as may be sufficient for ordinary algebra.

In the oldest treatises on algebra which exist, there is mention of a modification of quantity unknown in arithmetic, called *negative* quantity, as distinguished from *positive*. In the Viga Ganita [VIGA GANITA, BIOG. DIV.] we find this distinction and the rules for its use precisely as in modern treatises. One of the commentators says that negation is contrariety; and the 'Liliwati' contains the geometrical interpretation of a negative line—namely, a line measured in the direction contrary to that of a positive line. The commentator says that Patna is fifteen yojanas east, and Allahabad eight yojanas west, of a place called Varanasi; "the interval or difference is twenty-three yojanas, and is not obtained but by addition of the numbers. Therefore, if the *difference* between two *contrary* quantities be required, their *sum* must be taken." Surely it will be said that algebra began in a strange confusion of ideas; but yet the fault is rather in expression than in conception. An art was in existence presenting undoubted means of discovering truth, commencing with a generalisation of which the *use* was obvious, but not the *meaning*. In Diophantus we find the common rule announced as a definition (without even a previous notice of the distinction of quantities) in terms as broad as the following:—"Λεῖψις ἐπὶ λεῖψιν πολλαπλασιασθεῖσα ποιεῖ ὕπαρξιν," &c.—literally, "Defect upon defect repeated, makes existence." In Mohammed Ben Musa [ALGEBRA] the rules are announced in the same way, though the separate existence of positive and negative quantities does not seem to be assumed: it must be remembered that this work was written for popular use. The European promoters of algebra, with the exception only of Vieta, adopted the use of two species of quantities, positive and negative, with the explanation above noticed. Vieta not only avoided the negative quantity, but, so far as he could, dispensed with subtractive terms and subtraction itself. He discards the double nature of quantities in the words "Plus autem vel minus non constituunt genera diversa."

It is not our intention to follow the earlier algebraists through their different uses of negative quantities. These creations of algebra retained their existence, in the face of the obvious deficiency of rational explanation which characterised every attempt at their theory. Newton and Euler distinctly admit the existence of the quantity less than nothing: the latter asserts that a man who has no property, and is in debt 50 crowns, would only have nothing if any one else made him richer by a gift of 50 crowns, and therefore begins with 50 crowns less than nothing. Elementary treatises for the most part try to append an explanation of negative quantities to an algebra which is nothing more than arithmetic, instead of introducing those new abstractions which are the basis of the separate science: so that algebra, instead of being systematically learnt, is collected by slow and often dubious steps from arithmetical examples, in which the rules of operation of the former science are employed, preceded by the principles of the latter. Few, therefore, acquire a real perception of the meaning of the subject, except those who study mathematics to great extent. It is matter of notoriety that difficulties attend the beginner in algebra of a nature totally different from those which are found in geometry; so that while a person who has read a few books of Euclid may be imagined capable of writing an intelligent commentary on what he knows, another who has mastered a common elementary treatise on algebra is conscious only of a great increase of working power, with a glimmering of principles which owe their reception more to the never-failing accuracy of their results than to native evidence or logical deduction from easily admitted truths.

We must premise that, as in all other cases where the first principles of a science have been matter of dispute, it by no means follows that one view of the subject is the most easy to every mind. Something must depend on the intellectual constitution of the individual; and if this be most probably true in geometry, the remark applies with still greater force to algebra.

The first abstraction which meets us in arithmetic follows the transition from actual magnitudes (concrete numbers, so called) to their numerical representations. We then find general properties of numbers, in which we learn to consider number independently of a specific concrete unit. Thus we see in $7+5-3=7-3+5$ a relation equally true. whatever may be the nature or magnitude of the unit. When we drop the concrete number and rise to the abstract, we gain something more by the transition than immediately appears; and this the student should particularly note, because some of the succeeding difficulties which attend the passage into algebra are very similar in character, though preceded by a stranger and harder process. The operation of multiplication takes a power and a property which it had not before: thus if we denote concrete number by Roman numerals, and if we speak of yards, it is clear that 5 × VII = XXXV, or 7 yards taken 5 times is 35 yards. But we may not, therefore, say that VII × 5 = XXXV, for VII × 5, the number 5 multiplied by 7 yards [MULTIPLICATION], is an incongruous and unmeaning set of words, and it would be equally improper to say that it *is* and it *is not* 35 yards. In abstract numbers no such caution is necessary: 7 × 5 and 5 × 7 are both the same. If men had never considered *number* independently of magnitude measured or repeated by it, the arithmetician would have confounded VII × 5 and 5 × VII, because he would soon have found that no false results would have sprung therefrom; while VII × 5 would have been a sort of impossible quantity, useful in practice and difficult in theory.

We are now on the ground of abstract arithmetic, and on examining the four fundamental operations, we see no difficulty in either addition, multiplication, or division. So soon as we have mastered the subject of fractions, and have clearly admitted the introduction of a *part* of a repetition [MULTIPLICATION], we say as follows:—Let a and b be any two numbers or fractions, and $a+b$, ab, and $a:b$ must be real numbers or fractions, assignable by demonstrated operations so soon as a and b are assigned. But there is still a restriction upon the possibility of subtraction: $a-b$ has no imaginable existence, unless a be greater than b; when $a=b$, the magnitude of $a-b$ vanishes entirely, and when a is less than b, the direction to perform $a-b$ is just the same as asking for a part which shall be greater than the whole of which it is a part. If we confined ourselves to particular arithmetic, in which all numbers used have specific values, it would most likely be thought of no use to carry the subject further, and in one point of view correctly; that is, it would be of little moment to deduce methods by which an individual so careless as to write down and operate upon such a symbol as $3-4$ might be enabled to arrive at a subsequent correction of the mistake which a glance at the symbol should show him he has made. But when we use general symbols of number, we are liable to mistakes of two kinds, both dependent upon our liability to invert the order of terms of which the less should be subtracted from the greater.

First, we may mistake the nature of the quantity which results: thus if it be part of the conditions of a problem that I pay £a and receive £b, and if the application of the conditions requires that I should state how much I gain or lose, the answer should be either a loss of £$(a-b)$ or a gain of (£$b-a$), according as a or b is the greater. We have then the choice between adopting one of these with the chance of being entirely wrong, or of working the problem in two distinct ways. And if it should happen that the conditions of the problem present this alternative in six distinct instances (and sometimes it happens oftener), there would be no less than 64 cases of solution, all, arithmetically speaking, essentially different in the mode of obtaining the answer, whether the answers obtained be the same or different.

Secondly, we may make an error of the same kind in the details of operation. For instance, suppose we have $a+b-c$, which it is convenient to exhibit in the form of a altered by one single addition or subtraction. If we assume an addition, and write $a+(b-c)$, we may be in error; for if b be less than c, the proper alteration is $a-(c-b)$.

It is evident that both species of mistake are precisely of the same kind. Let us call them, for distinction, errors of interpretation and errors of operation, and let us show first that an error of interpretation will produce the error of operation and no other. If, in the first problem, we suppose $a-b$ to be lost where $b-a$ is really gained, and if the problem, for instance, require the result of the proceeding to be annexed to a loss x, we shall suppose there is altogether a loss of $x+(a-b)$, whereas it should be a loss of only $x-(b-a)$. Secondly, the error of operation will produce the error of interpretation, whenever any interpretation is made; for when we look at $x+(a-b)$ as a loss, we shall evidently suppose it to be more of a loss than x, or that $a-b$ is lost besides; whereas, had we looked at $x-(b-a)$, we should have inferred that there is a less loss than x. Now the first step of the young algebraist, before he attempts any transition from universal arithmetic to algebra, must be to examine by many instances the effect of both classes of errors upon the subsequent proceedings and results. We shall here only state the truths at which he will finally arrive, with an example of each. The beginner cannot, as the proficient may do, see a sufficient reason for these results in the common rules of algebraical operation; and we should doubt that anything but a large number of examples would serve to give him the necessary insight into the conclusions.

1. The mistake of operation, how often soever repeated, and how complicated soever the deductions which may be drawn from it, produces no result in any way different from that of the correct process; that is, its result can be reduced to the result of the correct process by the use of no more than those rules which apply in the rational process.

Thus if $x+a-b$, wrongly taken to be $x+(a-b)$; b being greater than a, be multiplied by $x+p-q$, wrongly taken as $x+(p-q)$, q being greater than p, we find as the (supposed) product

$$x^2+(a-b+p-q)\,x+(a-b)\,(p-q);$$

to which the application of the common rules gives

$$x^2+ax-bx+px-qx+ap-bp-aq+bq,$$

precisely the same as the product of $x+a-b$ and $x+p-q$. The reason of this is as follows:—In all the rational cases of the four operations, a term in the construction of which two signs are used has + before it, if those two signs be alike, and − if they be unlike, as in

$$a+b-(c-d),\text{ or }a+b-(0+c-d)$$
$$=a+b-c+d$$
$$(a-b)\;(c-d)\text{ or }(0+a-b)\;(0+c-d)$$
$$=0+ac-ad-bc+bd.$$

If then a term were subjected to the signs + +, it would make no difference if the same term were subjected to the signs + − −, for the effect of − − is the use of +. If then we take $x+a-b$ wrongly as $x-(b-a)$, we see that when we come to add this, say to c, we have

$$c+\left\{x-(b-a)\right\}$$

in which a, before it is disengaged, must come under the signs + − −, or, if the phrase be less objectionable, under the application of the rules to these signs, successively. But the correct process would give

$$c+\left\{x+(a-b)\right\}$$

in which a falls under the application of the rules to + +; and such application to + + gives the same result as that to + − −, necessarily and demonstrably, though in one of the two applications there is the symbol of absurdity. In the same way the other cases may be proved, whence it follows that however many of these simple operations may be performed, no result can arise except either that of the correct operation or one which may be brought to it by the operations on signs, already described.

We must here pause to remind the reader that errors, however palpable and admitted, are not necessarily productive of error. *True* reasoning, on *true* principles, *must* lead to *truth*; but if for true we write false, and for truth falsehood, we have no longer any right to say *must*, but only *most probably will*. If then we can show of a particular class of errors that, used in a certain way, the results agree with those of true reasoning on true principles, we may demand the use of these errors as demonstrated means of finding truth. The mind of man would never stop at such a point; but, for all that, we have the conclusion, as a logical consequence of the rules of arithmetic, that the mistake of the impossible subtraction introduced in operations, and not having previously vitiated the interpretation by which the fundamental objects of operation (equations) were deduced from the conditions of the problem, will produce no falsehood in the result.

2. Let us now examine the consequences of the error of interpretation. The effect of this is, that we write $a-b$ instead of $b-a$, but at the same time we suppose the quantity of which we are thinking to be of a diametrically opposite character to that which it ought to have. But also at the same time we add this symbol where we should subtract it, and *vice versâ*; so that where we should take $a-b$, and add, giving $c+(a-b)$, we make one mistake in taking $b-a$, and another in subtracting, giving $c-(b-a)$. When mere rules come to be applied, we find the same result from both, namely, $c+a-b$ and $c-b+a$. We might then so manage as to elude the actual presentation of the nega-

tive quantity, as in the following problem:—Two persons are now aged 50 and 40; at what date is (was, or will be, as the case may be) the first twice as old as the second? Let us suppose that we reach the date by going a years forward and afterwards b years back from the epoch to which we then come: here is a supposition which is perfectly competent to yield any result, before or after the present epoch, by properly assuming a and b. But we must now choose a supposition; let it be that the ratio in question exists at some future time, that is, a is greater than b. In $a-b$ years then the thing happens; consequently,

$$\begin{gathered} 50+(a-b)=2\{40+(a-b)\} \quad . \quad . \quad (1) \\ 50+a-b=80+2a-2b \quad . \quad . \quad . \quad (2) \\ 80+2a-2b-50-a+b=0 \\ 30+a-b=0 \\ b=a+30. \end{gathered}$$

Or any number of years forward and 30 more years back is all the answer the conditions of the problem will give, or the event took place 30 years ago. But the correctness of this reasoning is only a semblance, for the result contradicts the supposition on which it was obtained, namely, that a is greater than b. To increase 50 by the excess of a over 30 *more than* a is beyond the power of the arithmetician. If then it be taken that a is less than b, or that the event happened $b-a$ years ago, we have

$$\begin{gathered} 50-(b-a)=2\,(40-(b-a)) \quad . \quad . \quad (3) \\ 50-b+a=80-2b+2a \quad . \quad . \quad . \quad . \quad (4) \end{gathered}$$

and (4) is the same as (2); so that we arrive at the same result as before, and find our conclusion to justify the supposition on which it was made. The steps (1) and (3) differ to the same effect as if an error of operation had been made on (4) or (2) in retracing the steps.

In the preceding, by the use of two symbols, a and b, we have enabled ourselves to obtain a correct and intelligible answer, even by the incorrect process, since we end with the determination of $b-a$ $(=30)$, even where we reasoned on $a-b$. If however we had represented our unknown quantity by a single symbol, x, our first process would have stood as follows:—

$$\begin{gathered} 50+x=2\,(40+x)=80+2x \\ x=50-80 \end{gathered}$$

And the answer is obviously impossible. Our second process is,

$$\begin{gathered} 50-x=2\,(40-x)=80-2x \\ x=80-50=30. \end{gathered}$$

From such instances as the preceding it may be collected that an error of interpretation, which causes us to write $a-b$ instead of $b-a$, will, in finding the value of $a-b$, cause an impossible subtraction to appear; and *vice versâ*, that the appearance of an impossible subtraction in the result can arise from nothing but a primitive error of interpretation in fixing the nature of that result. This point must be well ascertained by every beginner from repeated instances.

Such a result as $3-8$ may be written $3-3-5$, or $0-5$; so that the error of attempting to subtract 8 from 3 is reducible to that of attempting to subtract 5 from nothing. At our present point we can say that the occurrence of $0-5$ shows us that the result which we supposed ourselves about to obtain was diametrically wrong in quality in our previous supposition: thus in the preceding problem we found $50-80$, or $0-30$, and the real answer is 30 in its magnitude, but instead of being, as we supposed, 30 years after the present time, it is 30 years before it.

Having arrived at this point, the earlier algebraists at once received such symbols as $0-5$ and $0-30$, which they wrote -5 and -30, into the list of algebraical objects of reasoning, calling them *negative* quantities, and treating them as diametrically opposite in meaning to 5 and 30, which should for comparison be written $0+5$ and $0+30$. These they called *positive* quantities. And, because, in all possible subtractions the remainder is less than the minuend ($a-b$ is less than a) they called $0-5$ less than nothing. The fault committed by elementary writers, in beginning algebraical works by an exhibition of these definitions without the least warning of the manner in which arithmetical terms had been extended, converted the whole science into a mystery.

If we extend the notion of quantity so as to give different names to those of diametrically opposite kinds, we may call one set of quantities direct, and the others inverse. Thus property and debt, distance north and distance south, time before and time after, ascent and descent, loss and gain, progression and retrogression, &c. &c., are of different kinds; either of any one pair may be called direct, but the other is then inverse. And in circumstances which require the addition of the direct quantity, the subtraction of the inverse is equally required: thus whatever an increase in A's property will augment, a diminution of it will diminish; whatever distance on a line of progression on that line will increase, retrogression will diminish. If then we have $a+b$ where we imagine both quantities were what we took them to be; but if it should turn out that b is of the contrary kind, we know that we should have had $a-b$. If we put $+b$ for the quantity we thought we were using, and $-b$ for its opposite, the ordinary rule of signs will be sufficient to make the conversions which the correction of the mistake requires. Thus if, attending only to the rule that like signs produce + and unlike signs −, we treat

$$a+(+b) \text{ and } a+(-b)$$

we find

$$a+b \text{ and } a-b;$$

or, in this instance, the affixing of + or − to a quantity according as our initial supposition is correct or incorrect, leaves us with our result if we were correct and makes the necessary alteration if we were incorrect. The application of the same reasoning leads to the same conclusion in all the cases of addition and subtraction. Observe also that if any one, disputing the propriety of making the signs + and − take a new meaning, should prefer, say, to denote direct quantity by the prefix of ¶, and inverse quantity by that of §, the rule he would arrive at by induction is that like signs produce + for operation, and ¶ for interpretation, while unlike signs produce − for operation and § for interpretation; here by like signs he would find he must mean + and +, or + and ¶, − and −, or − and §, and all others unlike. His final rule then would be, use ¶ as if it were +, and § as if it were −, so that he would ultimately differ from the algebraist by the continual use of two new signs without any new uses or practical meanings.

In the operations of multiplication and division the rule of signs is thus shown:—It is said that two negative quantities multiplied together produce a positive quantity, which means that a mistake of direct for inverse, or *vice versâ*, made in both the terms of a product, produces no mistake in the product, when the latter is formed by the usual rules. Thus, if a, which should be $x-y$, has been taken to be $y-x$, and if b, which should be $v-w$, has been taken to be $w-v$, the algebraical product

$$(w-v)\,(y-x) \text{ or } wy-wx-vy+vx$$

at which we arrive in the mistaken process, is precisely the same as

$$(v-w)\,(x-y) \text{ or } vx-vy-wx+wy$$

at which we should have arrived in the correct process.

The first step then from arithmetic to algebra is made by the following definitions:—

1. Quantities are distinguished into positive and negative, which are to be considered as of diametrically opposite kinds; and common arithmetical quantities (abstract numbers without signs) are to be considered as positive. 2. The rules of arithmetical algebra are to be applied to the extended algebra, and in all cases in which the latter presents a case unknown to the former, the rule of signs already known in the former must be applied. The extension which takes place in the terms *less than nothing*, &c., will be considered under the word NOTHING.

The preceding extension gives an extended meaning to all the terms of operation; thus addition is no longer the simple arithmetical process, but a compound operation, first reducing a multiplicity of signs to one alone, and then following the direction of that sign; and the same of subtraction. Thus $a-(-b)$ is $a+b$. It may be asked then how we are to trace our steps through any problem so as to form its equation out of symbols which seem to have various meanings; for it might appear as if the + of algebra were either the + or − of arithmetic, as the case may be. The answer is very simple: since the extended algebra is no more than arithmetic in its actual operations, however the meaning of those operations may be extended, we may be sure that if we assign a particular case of a problem, and treat it entirely as in arithmetic, we are, though with one case only in view, performing upon limited symbols (limited because we think at the time only of a limited meaning) the same steps which we should have to follow if we could, by one act of the mind, grasp the symbols in their utmost generality.

NEGATIVE RADICALS. [ORGANIC RADICALS.]

NEGOTIABILITY. [BILL OF EXCHANGE.]

NEMEAN GAMES, one of the four great national festivals of the Greeks, derived their name from Nemea, a village in the north-eastern part of Argolis, on the borders of the Corinthian territory. They were celebrated under the presidency of the Corinthians, Argives, and inhabitants of Cleonæ (Scholiast. on Pindar); but in later times they appear to have been entirely under the management of the Argives. (Liv., xxxiv. 41.) They are said to have been celebrated every third year; and sometimes, as we learn from Pausanias, in the winter (ii. 15, § 2; vi. 16, § 4).

The Nemean games were (according to some legends) first established by the Epigoni, in memory of Opheltes (Schol. on Pind.; Apollod., iii. 6, 4; Paus., x. 25, § 2); others attribute their foundation to Hercules, in honour of Zeus, in consequence of his victory over the Nemean lion.

The games, at first of a warlike character, afterwards consisted of horse and chariot racing, boxing, wrestling, archery, and casting the spear. The crowns bestowed on victors were made of parsley [OLYMPIC GAMES.]

NEMESIS (Νέμεσις), a female Greek divinity, who appears to have been regarded as the personification of the righteous anger of the gods. She is represented as inflexibly severe to the proud and insolent (Paus., i. 33, § 2.); but she also sets right the inequalities of fortune, and avenges wrong doing: in some respects Nemesis is the equivalent of conscience. According to Hesiod, she was the daughter of Night, by others she is called the daughter of Erebus. ('Theog.,' 228; compare Paus., vii. 5, § 1.) There was a celebrated temple sacred to her at Rhamnus, one of the demi of Attica, about sixty stadia distant from Marathon. In this temple there was a statue of the goddess, made from a block of Parian marble, which the Persians had brought thither to erect as a trophy of their expected victory at Marathon. Pausanias says that this statue was the work of Phidias (i. 33, § 2, 3); but Pliny ascribes it to Agoracritus; and adds that it was preferred by M. Varro to all other statues which existed. ('Hist. Nat.,' xxxvi., 4, § 3.) A fragment, supposed by some to be the head of this statue, was found in the temple of Rhamnus, and was presented to the British Museum in 1820: it is now No. 325, in the Elgin Saloon. The inhabitants of Rhamnus considered Nemesis to be the daughter of Oceanus. (Paus., vii. 5, § 1.)

The practice of representing the statues of Nemesis with wings was first introduced after the time of Alexander the Great by the inhabitants of Smyrna, who worshipped several goddesses under this name. (Paus., vii. 5, 1; ix. 35, 2.) She is often figured on ancient coins and gems, and sometimes with the attributes of Tyche. According to Müller ('Archäol. der Kunst,' § 398; and see 'Denkmäler der Alten Kunst,' Taf. lxxiv.), in early art Nemesis bore a strong likeness to Aphrodite: later there was more of symbolism in representations of her.

According to a myth preserved by Pausanias, Nemesis was the mother of Helen by Zeus; and Leda, the reputed mother of Helen, was only her nurse (i. 33, § 7); but this myth seems to have been invented in later times to represent the divine vengeance which was inflicted on the Greeks and Trojans through the instrumentality of Helen.

There was a statue of Nemesis in the capital at Rome; though we learn from Pliny that this goddess had no name in Latin. ('Hist. Nat., xxviii. 5; xi. 103.)

NEOLOGY. [RATIONALISM.]

NEOPHYTES (from a Greek word which means "newly planted") is the appellation given to the converts to Christianity who have just received baptism. In the early church the Neophytes, after that solemn ceremony, wore white garments for eight days. They were also subject to a strict discipline or probation for a much longer period. The Jews, Mussulmans, or Pagans, who are converted to Christianity, are called Neophytes by the Roman Catholic missionaries, and there are houses at Rome and other places for their reception and instruction.

NEPHRITIS, inflammation of the substance of the kidney. Idiopathic nephritis is a very rare disease. When present more or less pain is felt in the region of the kidney, which is sometimes referred to the umbilicus. The pain also shoots along the ureters, and there is a sense of numbness down the thigh, and in the male there is often pain and retraction of the testicle. A frequent desire is felt to pass the water, which is sometimes pale, but more frequently of a deep red colour. There are nausea and vomiting, and the bowels are constipated. There are also the general symptoms of inflammatory fever. Sometimes the inflammation proceeds to suppuration, and then pus is found in the urine.

In this disease the kidney after death presents a softened structure, and the veins are loaded with blood.

Not only is the substance of the kidney subject to inflammation, but the mucous membrane lining the tubuli and the pelvis may be the seat of diffuse suppurative or ulcerative inflammation, and to this condition the name *pyelitis* has been given.

Inflammation of the kidneys is most frequently produced by the presence of a calculus in the pelvis of the kidney, an occurrence which is ordinarily called "gravel." Gravel may however exist without producing nephritis or pyelitis, but is usually accompanied by severe pain in the region of the kidneys which is called *nephralgia*. The deposits thus impacted in the kidney are of various kinds, which form calculi in the bladder and deposits in the urine after it has been passed. [URINE, MORBID STATES OF.]

Nephritis and pyelitis may be the result of stricture in the urethra which acts by preventing the free discharge of urine, and causes inflammation of the ureters, which extends at last to the kidney.

In the treatment of these diseases it is most important to ascertain and remove the cause. When there is pus in the urine, and the other symptoms of nephritis, the first inquiry should be the state of the urethra, and if stricture exists, it must be relieved. [URETHRA, DISEASES OF.]

In idiopathic nephritis the treatment must be directed to the reduction of the inflammation, and cupping over the loins; purgatives and opiates will be found most effectual, and time must be given for the passage of the concretions from the kidneys into the bladder, from whence they are discharged by the urethra.

NEPTUNE, the most remote of the known members of the planetary system. The discovery of this planet by means of an investigation founded on the perturbations which it produces in the movement of the neighbouring planet Uranus, must ever be regarded as one of the most brilliant feats in the annals of science. We proceed to give a brief sketch of the circumstances which led to this memorable achievement of pure theory.

Soon after the discovery of the planet Uranus by the elder Herschel, in 1781, it was found that it had been observed as a star on several previous occasions by various astronomers who were unacquainted with its planetary nature. The earliest of these observations dates from the year 1690, and is due to Flamsteed. The remaining places of the planet were determined partly by the same astronomer, and partly by Le Monnier and Mayer. These early observations were found exceedingly useful for determining the orbit of the planet, subsequently to its discovery by Herschel. In 1821 Bouvard, the French astronomer, published new tables of Uranus, in the introduction to which he announced an unexpected result. He experienced no difficulty in satisfying the earlier observations of the planet by an elliptic orbit of determinate elements, nor in similarly representing the observations made subsequently to its discovery in 1781, but he found it impossible to include both sets of observations in the same orbit. He accordingly rejected the earlier observations of the planet, and constructed his tables exclusively on the basis of the more modern, leaving the discovery of the anomaly to future research. He appears to have suspected that the discordance was due to the disturbing action of some unknown planet. A few years afterwards this explanation received some support from the circumstance that the observations of the planet made subsequent to the year 1821, began to exhibit a deviation from Bouvard's tables. This deviation continued to increase, until at length in the year 1830, the error in longitude amounted to as much as half a minute of space.

In the year 1834, Dr. Hussey, writing to Mr. Airy, announced that he found it impossible to reconcile his own recent observations of the planet with Bouvard's tables. Taking this fact in connection with the discordances which the French astronomer found to exist between the earlier and the more modern observations, he suggested whether the various errors might not be attributable to the action of some planet beyond Uranus, and he expressed his intention of sweeping for the undiscovered body with his large reflector, provided one or two positions of it were determined empirically. Similar suspicions of the existence of an exterior planet occasioning the anomalies in the movement of Uranus were entertained by M. Valz, Mrs. Somerville, Professor Mädler, and several others.

It would appear that Bessel, shortly before his death, had formed the resolution of determining the position of the undiscovered planet by an analytical investigation of the subject. On the occasion of a visit which he paid to England in 1842, he expressed to Sir John Herschel his firm conviction that the anomalies were due to the disturbing action of an exterior planet, and he stated that as soon as he had concluded certain researches in which he was engaged, he would seriously apply himself to the question of ascertaining its actual position. In accordance with this resolution he caused all the observations of the planet to be carefully reduced by M. Flemming, a young German astronomer, but he was soon afterwards seized with the illness of which he died, and no further progress was made in the inquiry.

The theory of Uranus was shortly afterwards taken up as a subject of analytical investigation by Mr. J. C. Adams, of St. John's College, Cambridge. He was first led to suspect that the errors in the tables of the planet were due to the disturbing action of some planet revolving beyond Uranus, by a perusal of Mr. Airy's account of the progress of astronomy published in the 'Report of the British Association,' for 1832. In his note-book he found the following memorandum inserted under the date of July 3, 1841. "Formed a design, in the beginning of this week, of investigating, as soon as possible after taking my degree, the irregularities in the motion of Uranus, which are yet unaccounted for; in order to find whether they may be attributed to the action of an undiscovered planet beyond it, and if possible. thence to determine approximately the elements of its orbit, &c., which would probably lead to its discovery."

Mr. Adams took his degree in January, 1843, and shortly afterwards proceeded to a consideration of the theory of Uranus. The determination of the position of the undiscovered planet by means of the outstanding errors in the motion of Uranus involves the solution of what is called the inverse problem of perturbation. It was necessary, in the outset of his researches, to make some assumption with respect to the distance of the undiscovered body. In accordance with Bode's law of the planetary distances, he supposed the distance of the exterior planet from the sun to be equal to twice the distance of Uranus from the sun. In the autumn of 1845 his researches were so far matured as to suggest the expediency of instituting a search for the undiscovered body. On one of the last days of October, 1845, he called at the Royal Observatory and left a paper containing the following elements of the planet, which he had ascertained by a course of rigorous investigation:

Mean distance from the Sun, the earth's distance being represented by unity	38·4
Mean sidereal motion in 365·25 days . . .	1°30′·9
Mean longitude, October 1, 1845	323° 34′
Longitude of perihelion	315·55
Excentricity	0·1610
Mass (that of the Sun being unity)	0·0001656

These elements give 326° 37′ for the true heliocentric longitude of the planet on October 1, 1845. The elements of the planet, derived from observations made subsequently to its discovery, assign 324° 48′ as its longitude for the same day. The difference therefore between the theoretical and the actual places of the planet amounts to only 1° 49′. The errors in the longitude of Uranus were shown to be accounted for most satisfactorily by the disturbing action of the hypothetic planet.

"Thus it appears that as early as the month of October, 1845, seven months before any other person had arrived at a similar conclusion, Mr. Adams had solved the inverse problem of planetary perturbation; that by means of his solution he had discovered, theoretically, the existence of a planet exterior to Uranus; and that he had assigned to the unknown body a place in the heavens which was subsequently found to differ little more than one degree from its actual place. All that was now wanting therefore to assure, both to Mr. Adams and to his country, the undivided honour of one of the noblest discoveries recorded in the annals of science, was some zealous observer to give effect to his results by carefully searching the heavens in the vicinity of the place indicated by his theory as that occupied by the planet. If such a scrutiny had been undertaken, and prosecuted for some time, it would beyond all doubt have resulted in the actual discovery of the planet, and the name of Adams would have been alone associated with that remarkable triumph of science. Such a consummation was not destined to be the reward of Mr. Adams; but this circumstance does not detract in the slightest degree from the merits of his researches; for it is now universally admitted that he was the first theoretical discoverer of the planet, and that as far as the task of the mathematician was concerned he left no part of the problem relative to the determination of its actual position to be completed by others."*

Shortly after receiving Mr. Adams's communication respecting the trans-Uranian planet, Mr. Airy wrote to Mr. Adams requesting to know whether the errors in the radius vector of Uranus were accounted for by the action of the undiscovered planet as satisfactorily as the errors in longitude. He considered that the explanation of the errors of the radius vector would form an *experimentum crucis* for testing the validity of Mr. Adams's researches, and he has stated that if a satisfactory reply had been returned to his communication he would at once have taken steps to institute a search for the planet.† Mr. Adams inadvertently omitted to furnish Mr. Airy with the desired information. This is more especially to be regretted as it would not have cost him the slightest effort to have returned a satisfactory reply to the Astronomer Royal.

It is right to state that the remarkable researches of Mr. Adams were not hitherto published. In fact it does not appear that at this period any one was acquainted with his labours except a few of his friends at Cambridge and the Astronomer Royal.

Allusion has been made to the failure of Bouvard's attempt to construct tables of Uranus capable of representing all the observations of the planet. A similar attempt of his nephew, Eugene Bouvard, in 1845, was not attended with much greater success. It was probably this circumstance which induced the late M. Arago, in the same year, to propose to M. Le Verrier, as a subject of investigation, the irregularities in the motion of Uranus. M. Le Verrier was engaged at the time in researches on the movements of comets, but he did not hesitate to adopt the suggestion of M. Arago, and laying aside his cometary labours for a future occasion, he commenced a rigorous investigation of the theory of Uranus. On the 10th of November, 1845, he communicated to the Academy of Sciences of Paris an account of the first part of his researches. They consisted in a new determination of the elements of the planet and a careful investigation of the perturbations produced in its motion by all the known bodies of the planetary system which are capable of exercising a sensible influence. On the 1st of June, 1846, M. Le Verrier communicated to the Academy of Sciences an account of the second part of his researches on the theory of Uranus. Finding it impossible to account satisfactorily for all the observations of the planet by the existing theory, he was led to consider whether the outstanding discordances between theory and observation might not be due to the disturbing action of some planet revolving beyond Uranus, and the problem which now presented itself to him was to determine the whereabouts of the unknown body, corresponding to a given instant of time. The final result which he deduced at this stage of his labours was, that on the 1st of January, 1847, the true heliocentric longitude of the planet was 325°, and that the probable error did not exceed 10°.

The close accordance exhibited between the results arrived at by Mr. Adams and M. Le Verrier, independently of each other, afforded strong evidence in favour of the theory on which they were founded. Mr. Airy was consequently induced to suggest to Professor Challis, of Cambridge, the desirableness of instituting a search for the planet with the large telescope of the Observatory, known as the Northumberland refractor. Professor Challis adopted the views of the Astronomer Royal, and commenced a systematic search for the planet on the 29th of July.

On the 31st of August, 1846, M. Le Verrier communicated to the Academy of Sciences an account of the third part of his researches on the theory of Uranus. The following are his final results in regard to the orbit of the unknown planet:—

Semi-axis of the orbit	36·154
Sidereal revolution	217·387 years.
Excentricity	0·10761
Longitude of the perihelion	284° 45′
Mean longitude, January 1, 1847 . . .	318° 47′
Mass	$\frac{1}{9300}$
True heliocentric longitude, January 1, 1847 .	326° 32′
Distance from the sun, January 1, 1847 . . .	33·06

On the 2nd of September, 1846, Mr. Adams communicated to the Astronomer Royal the final results of his researches on the disturbing planets. On this occasion he diminished the hypothetic value of the mean distance from 38 to 37·5. The following are the values of the other elements as deduced by him.

Mean longitude, October 1, 1846 . . .	323° 2′
Longitude of the perihelion	299° 11′
Excentricity	0·12062
Mass	0·00015003

On the 18th of September, 1846, M. le Verrier addressed a letter to Professor Encke, the Director of the Berlin Observatory, announcing to him the results of his researches on the trans-Uranian planet, and requesting him to institute a search for it in the region indicated by theory. This letter was received at Berlin on the 23rd of the month. On the same evening, Dr. Galle, Professor Encke's assistant, examined the regions of the heavens indicated by M. Le Verrier, as comprising the locus of the disturbing planet, with the assistance of the corresponding map of the Berlin Academy, which had just been engraved, and he found that a star of the eighth magnitude, situate very near the place assigned by M. Le Verrier to the disturbing planet, was not laid down on the map. An examination of the same region on the following evening established beyond doubt the interesting fact that the object thus observed was the planet. The following comparison will serve to show how nearly M. Le Verrier approximated in his researches to the actual position of the planet:

True heliocentric longitude, September 23, 1846 .	326° 57′
Longitude assigned by the theory of M. Le Verrier .	326
Difference between observation and theory .	57′

Professor Challis, who had commenced a systematic search for the planet, as early as the 29th of July, first received information of the discovery of the planet by Galle, on the 1st of October. He had already noted down the positions of 3150 stars comprised in the region which he proposed to explore. He now proceeded to discuss the results, in order to ascertain whether they included any places of the disturbing planet. It appeared from this examination that he had determined the position of the planet on the evening of August 4, and also on August 12, and it consequently followed that his plan of search, when carried into complete effect, would have infallibly led to the discovery of the planet. He also observed a star on the 29th of September, which seemed to have a disk, but unfortunately he did not establish the real nature of the object, which turned out afterwards to be the planet.

By the unanimous concurrence of astronomers, the new member of the planetary system has been called Neptune. It is plain from the brief account which we have given, that its theoretical discovery is due to the independent researches of Mr. Adams and M. Le Verrier. It is true that the optical discovery of the planet was effected solely by the aid of M. Le Verrier's indications, but it is equally true that the same object might have been achieved by means of Mr. Adams' theoretical results; and indeed we have seen that Professor Challis obtained two positions of the planet, solely by relying on the latter.

Soon after the discovery of the planet Neptune, it was found that it had been observed as a star by Lalande, on the 10th of May, 1795. This circumstance enabled astronomers to determine the orbit of the planet with a greater degree of precision than could otherwise have been expected until after the lapse of several years. The following elements of the orbit of the planet are due to the late Mr. Walker, of Washington, U. S.

Mean distance	30·0363
Mean longitude, January 1, 1847, M.T. Greenwich .	328° 32′ 44″·20
Excentricity	0·00871946
Longitude of perihelion	47° 12′ 6″·50
Longitude of ascending node	130° 4′ 20″·81
Inclination	1° 46′ 58″·97
Mean daily motion	21″·55448
Periodic time	164·6181 trop. years.

These elements represent the observations of the planet with a remarkable degree of precision. It will be seen that they differ in several respects very considerably from the corresponding results obtained by Mr. Adams and M. Le Verrier. This circumstance presented a difficulty to the minds of several persons, who even went so far as to assert that the planet Neptune did not represent the theoretical planet indicated by the researches of those geometers, and that its discovery was the result of a happy accident! But any such difficulty will vanish when it is borne in mind that the object proposed by M. Le Verrier and Mr. Adams was not to determine rigorously the elements of the disturbing planet, which could only result from the discussion of a series of its observed positions, but merely to ascertain its whereabouts during the period when its perturbations were sensible. For this purpose, any combination of elements varying within considerable limits will be sufficient. During the whole of the period comprised between the year 1690 and the beginning of the present century, the disturbing action of Neptune was incapable of exercising any appreciable influence on the motion of Uranus. During the present century, however, the perturbations have been of sensible magnitude. It was therefore necessary that throughout this period the intensity and direction of the disturbing force, and consequently the position of the disturbing body, should be represented with considerable precision by the theoretical results of M. Le Verrier and Mr. Adams. That this object was effected by both of the geometers just mentioned may be readily seen by the following numbers, which exhibit a comparison between the heliocentric longitude and radius vector of Neptune for every ten years since the year 1800, and the corresponding values of the co-ordinates, as deducible from the researches of M. Le Verrier and Mr. Adams:—

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* Grant's 'History of Physical Astronomy,' p. 173.

† Mem. Ast. Soc., vol. xvi.

Year.	Planet Neptune.		Theory of Le Verrier.		Theory of Adams.			
					First Approximation.		Second Approximation.	
	Longitude.	Rad. vect.	Longitude.	Rad. vect.	Longitude.	Rad. vect.	Longitude.	Rad. vect.
1800	226° 4′	30 30	231° 34′	33·57	236° 46′	36·31	238° 9′	34·90
1810	247 20	30·28	251 10	32·80	254 13	34·75	256 39	33·92
1820	268 52	30·23	271 28	32 35	273 11	33·45	276 5	33·25
1830	290 31	30·55	292 8	32·29	293 27	32·56	295 54	32·96
1840	312 17	30·06	312 36	32·63	314 30	32·22	316 10	33·11
1850	334 12	29·96	332 25	33·32	335 36	32·48	335 50	33·67
1860	356 14	29·87	351 17	34·26	356 1	33·30	334 39	34·57

Shortly after the discovery of Neptune, Mr. Lassell discovered that it was attended by a satellite. M. Otto Struve found from his own observations, made with the great refractor of Pulkowa, that the semi-major axis of its apparent orbit is 17″·89, and that it revolves round the planet in a period of $5^d\ 21^h\ 15^m$. These elements give for the mass of the planet the value $\frac{1}{\text{[illegible]}}$, the sun's mass being represented by unity. Professor Peirce, of Harvard College, Cambridge, U.S., determined the mass of the planet from observations of the satellite made by the late Mr. Bond, Director of the Cambridge Observatory, and found it to amount to $\frac{1}{\text{[illegible]}}$, in terms of the same unit. Adopting this value of the mass, Professor Peirce calculated the perturbations produced by the planet in the motion of Uranus, and he obtained results which on the whole represent very satisfactorily the irregularities in the motion of the latter planet which so much perplexed astronomers previously to the discovery of Neptune. It will be seen that the mass of Neptune, as deduced from the observations of the satellite either by M. Otto Struve or Mr. Bond, is considerably less than the value of the same element assigned by Mr. Adams or M. Le Verrier. It is to be borne in mind, however, that, on the other hand, the researches of both these geometers make the distance of the planet from the sun greater than the true distance. A compensation is thus effected, so that the *intensity* of the disturbing force presents a satisfactory agreement in all three cases. How nearly the *direction* of the disturbing force agrees in so far as regards the real and the theoretical planets, has been shown by the table just given.

M. Kowalski has recently published tables of Neptune, which are used in the 'Nautical Almanac' for computing the ephemeris of the planet. Mr. Adams's researches on the theory of Uranus are to be found in the Supplement to the Nautical Almanac for 1851; those of M. Le Verrier on the same subject are published in the 'Connaissance des Temps' for 1849.

NEPTUNUS. [POSEIDON.]

NEREIDS (Νηρηΐδες), nymphs of the sea, or rather of the Mediterranean, in contradistinction to the Naiades, who were the nymphs of fresh waters, and to the Oceanides, who were nymphs of the great ocean. The Nereids were the daughters of Nereus and Doris. Nereus was the eldest son of Pontus and the Earth (Hesiod, 'Theog.,' 233); and Doris was one of the daughters of Oceanus. The Nereids are said by most ancient writers to have been fifty in number, but Propertius makes them a hundred (III. 5, 33). The most celebrated of them were Amphitrite, the wife of Poseidon; Thetis, the mother of Achilles; Galatea, Doto, &c. (Homer, 'Iliad, xviii., 39–50, &c.)

The worship of the Nereids was generally connected, as might be supposed, with that of Poseidon. Thus they were worshipped in Corinth, where Poseidon was held in especial honour, and in other parts of Greece. They were the patrons of the Argonauts, and seafaring people generally. (Paus., ii. 1, § 7, 8; compare iii. 26, § 5; v. 19, § 2.) The Nereids are frequently represented on relievi, gems, &c. They are usually represented as beautiful nymphs [NYMPHS], mostly half draped, but sometimes unclothed. They are often figured sporting with Tritons; sometimes riding on sea-panthers, griffins, the hippocampus, and other sea monsters. They are also seen as they were described by later writers, as beings with green hair, and with the lower part of their body like that of a fish (Plin., 'Hist. Nat.' ix. 4); unless those on Greek gems are rather to be regarded as female Tritons.

NESTORIANS. [NESTORIUS, in BIOG. DIV.]

NET and LACE. [WEAVING.]

NEURALGIA, a word of modern origin (derived from νεῦρον, a "nerve," and ἄλγος, "pain"), first employed by Chaussier to designate a certain class of diseases of which the characteristic symptom is a most acute pain following the course of a nerve in one or more of its ramifications, subject to paroxysms and intermissions, in most cases unattended by either heat, redness, or swelling, and often without any apparent lesion at all.

Although from the nature and causes of the affection we have every reason to believe that neuralgia must have existed in all ages, still (historically speaking) it may be called a modern disease, as the first distinct description of it that we possess is that published by André, a surgeon of Versailles, in 1756, in his 'Observ. Prat. sur les Maladies de l'Urèthre.' He, however, had only met with one species, namely, *Neuralgia Faciei*, which he called "tic douloureux,"* a name which, in popular language, it still retains; but since his time the same disease (subject only to certain local modifications) has been observed in various other parts of the body, and it is probable that every sensationary nerve is liable to the same morbid condition. Chaussier has enumerated nine species (of which the three first are merely varieties of the neuralgia faciei), namely: 1. *Neuralgia frontalis*, which is seated in the frontal division of the first or ophthalmic branch of the fifth pair of cerebral nerves. The pain begins at the supra-orbital foramen, and extends to the forehead, the upper eyelid, the eyebrow, the caruncula lachrymalis, the inner canthus of the eye, and sometimes to the whole of that side of the face. 2. *Neuralgia sub-orbitalis*, which occupies the superior maxillary nerve, or second division of the fifth pair. The pain begins at the infra-orbital foramen, and extends to the cheek, the upper lip, the alæ nasi, the lower eyelid, and the teeth of the upper jaw. 3. *Neuralgia maxillaris*, which is seated in the inferior maxillary nerve, or third division of the fifth pair. The pain commences at the mental foramen, and either extends to the chin and lip, or else to the teeth of the lower jaw, the tongue, and the temple. 4. *Neuralgia Ilio-scrotalis*, which occupies the ilio-scrotal nerve, or external division of the musculo-cutaneous branches given off by the lumbar plexus, and derived from the first lumbar nerve. The pain commences at the crista ilii, follows the spermatic cord, and extends to the scrotum and the testicle. 5. *Neuralgia femoro-poplitealis*, which is seated in the great sciatic nerve. The pain begins over the sacrum, or about the great trochanter, follows the course of the nerve down the posterior part of the thigh to the popliteal space, and thence extends along the peroneal nerve, or external division of the great sciatic, to the outside of the foot. 6. *Neuralgia femoro-prætibialis*, which occupies the crural nerve, given off by the lumbar plexus, and derived from the second, third, and fourth lumbar nerves. The pain commences at the crural arch, extends along the anterior and internal part of the thigh, and sometimes follows the course of the internal saphenous nerve, one of the *deep-seated* branches of the crural, to the inner ankle and the dorsum of the foot. 7. *Neuralgia plantaris*, which is seated in the external and internal plantar branches of the posterior tibial nerve, or internal division of the great sciatic. The pain begins at the heel, shoots across the sole of the foot, and extends sometimes up the calf of the leg towards the knee. 8. *Neuralgia cubito-digitalis*, which occupies the ulnar nerve, given off by the brachial plexus, and derived from the fifth, sixth, seventh, and eighth cervical nerves. The pain sometimes commences at the upper part of the arm, and follows the course of the nerve along the ulnar border of the fore-arm to its termination in the inside of the middle, the ring, and the little fingers; sometimes only part of the nerve is affected, and the pain is confined to the humerus, or commences at the elbow. 9. "*Névralgies Anomales*: douleurs ordinairement chroniques, dont le siège varie à l'infini." Several of these have been particularly described, and constitute so many additional distinct species:—1. *Otalgia* (described by M. Itard), which is seated in the corda tympani, a portion of the vidian nerve, or posterior branch of Meckel's ganglion; and which is characterised by an acute pain following the course of this nerve. 2. *Neuralgia cervicalis* is of rare occurrence: M. Bosquillon has observed two cases after opening the external jugular vein, in consequence of wounding the superficial branches of the cervical plexus formed by the anterior branches of the second, third, and fourth cervical nerves; and M. Jolly has met with another after the application of leeches to the side of the neck. 3. *Neuralgia intercostalis* (first described by Siebold, and afterwards by Corvisart) occupies either a portion or the whole of one of the intercostal nerves, generally in the lower part of the thorax. 4. *Neuralgia cervico-brachialis* (first noticed by Professor Fulci of Catana), is seated in the internal cutaneous nerve, a branch furnished by the brachial plexus. The pain begins at the anterior and internal part of the shoulder, and descends along the inner side of the arm and fore-arm to the wrist. Sometimes it extends not only to all the branches of the internal cutaneous nerve, but also to those of the external, and then becomes confounded with the following species. 5. *Neuralgia musculo-cutanealis* was first described by M. Martinet, and occupies the external cutaneous (or *musculo-cutaneous*) nerve, another branch derived from the brachial plexus. The pain commences at the shoulder, descends along the anterior external surface of the arm and fore-arm as far as the wrist. 6. *Neuralgia supra-scapularis* was also first described by M. Martinet, and is seated in the suprascapular nerve, another branch given off from the brachial plexus. The pain begins at the inferior angle of the scapula, passes along its posterior surface, and sometimes descends along the radial border of the fore-arm to the thumb and fore-finger. 7. *Neuralgia mammæ*, first described by Dr. Good as consisting of "sharp, lancinating pains, divaricating from a fixed point in the breast, and shooting equally down the course of the ribs and of the arm to the elbow; the breast retaining its natural size, complexion, and softness." 8, and last, *Neuralgia of the facial nerve, or portio dura of the seventh pair*, about the existence of which there is great room for doubt; for as this is a nerve of *motion* and not of *sensation*, it is not easy to understand how it should be liable to be affected by a disease which is in general simply and purely painful. However, it is still more difficult to deny the fact; numerous instances have occurred in which the disease has (to all appearance) been seated in this nerve, and several wherein the pain has not only followed its ramifications with great exactness, but has also been attended by convulsive twitchings of the facial muscles, and even by their paralysis.

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* The meaning of the term *Tic Douloureux* appears to be rather doubtful. In the '*Dictionnaire de Trévoux*,' the word *Tic* is said to mean, first, a vicious trick that horses have of biting the manger; and secondly, "a sort of convulsive movement to which some persons are subject." These twitchings not being accompanied with pain, the epithet "douloureux" was added to distinguish those in neuralgia from every other sort. Dr. Good, however, considers the word *tic* to be "an onomatopy, or sound expressive of the action it imparts." The "Tic Douloureux" is called "Dolar crucians Faciei," by Fothergill; "Trismus Maxillaris," and "Trismus Dolorificus," by Sauvages; "Prosopalgia," by Swediaur: "Neuralgia Faciei," by Good; "Autalgia Dolorosa," by Young.

But besides these external forms of neuralgia, the disease has sometimes been found to attack various internal organs. This was first suggested by Dr. John Fothergill in 1778, who says (in Vol. v. of the 'Med. Observ. and Enquiries,') "There are few physicians, I believe, who may not in reviewing many cases, which have occurred to them, of anomalous pains in different parts of the body, so as sometimes to counterfeit gouty, bilious, and other internal affections of the stomach and bowels, perceive some analogy between them and the complaint here pointed out;" but it is only lately that pathologists have begun to enumerate these "anomalous pains," and class them as so many distinct species of neuralgia. Sometimes the central mass of the nervous system is affected, and we find the terms "Cerebralgia" and "Myelalgia" employed by some modern French authors to designate neuralgia of the brain and of the spinal chord. (Raciborski, 'Précis du Diagnostic,' 1837.) Sometimes, instead of the branches of a nerve, the extreme filaments only are diseased, as would appear to be the case in many of those kinds of pain commonly called "rheumatic" (MM. Jolly and Piorry, quoted in Raciborski). To these have been added torticollis, lumbago, angina pectoris, neuralgia of the arteries, gastralgia, enteralgia, hepatalgia, nephralgia, hysteralgia, neuralgia of the heart, testicle, bladder, urethra, diaphragm, &c. (Rociborski, Rowland, Elliotson, &c.) It may perhaps be rather fanciful to give the name "neuralgia" to all these cases, and it would take up too much space to describe each separately; but they are all characterised by an increased sensibility of the nerve, and have the same general character of coming on in paroxysms at regular or irregular intervals.

Of the remote or predisposing causes of neuralgia very little is known, but it has been supposed to attack females more frequently than males, the rich than the poor, those that live in towns rather than the inhabitants of the country. It is also most common among persons of a nervous temperament, and both infancy and old age are comparatively safe from its attacks. The immediate or exciting causes are very numerous, and sometimes extremely obscure. Among the most common may be mentioned, exposure to wet and cold, mental excitement and agitation in persons of an irritable temperament, and a deranged state of the digestive organs. Local injuries of various kinds are another very frequent cause of the disease; such as the lodgment of any foreign body in the branch of a nerve, wounds, contusions, cicatrices, the too great distension of a nerve, carious teeth, &c. Sir Henry Halford has published in his 'Essays,' five cases showing that sometimes "the disease is connected with some preternatural growth of bone, or a deposition of bone in a part of the animal economy where it is not usually found in a sound and healthy condition of it, or with a diseased bone;" and Sir Benjamin Brodie, in his 'Lectures on Local Nervous Affections,' mentions several where the pain was occasioned by the pressure of an aneurysmal or other tumour. Another cause is exposure to malarious poison. This is more especially the case in those attacks which are regularly intermittent, and which yield to the same treatment as ague. Puerperal women are also subject to this disease, especially after large floodings during labour.

With regard to the seat of neuralgia, there can be little doubt but that it is in the nerve itself; but it is equally certain that the part where pain is felt is not always the part diseased. The fact is, neuralgia of any nerve may be purely the result of irritation reflected from a very distant point of the nervous system. Post-mortem examination throws no light on the state of the nerve, but there is no reason to believe that it arises from an inflamed or congested state of the nerve in which the pain has been experienced.

The diagnosis of neuralgia is not in general very difficult, for even when it does not follow the course of a nerve, it may commonly be distinguished from every other disease by the peculiar character of the pain, its excessive violence during the paroxysm, and the absence of all symptoms of fever and inflammation. It may sometimes be difficult at first sight to distinguish neuralgia from rheumatism, inasmuch as the two diseases resemble each other in some of their most prominent symptoms; but by observing the following diagnostic signs (derived from the general character of inflammation in all parts of the body), the danger of confounding them may be avoided. In rheumatism the pain is continual, as is the case in all inflammations: in neuralgia it is never constant, but is subject to paroxysms and intermissions. In rheumatism the pain is aggravated by the slightest pressure; in neuralgia, on the contrary, it is sometimes alleviated by it. To these it may be added that in rheumatism we shall find the usual attendants of inflammation, namely, heat, redness, and swelling; while in neuralgia (as noticed above) these are rarely if ever present.

Dr. Inman has recently pointed out that a painful condition of the muscles, ordinarily known by the name of cramp, is frequently mistaken for neuralgia. This disease, which he calls myalgia, he says may be recognised: 1. By the pain being hot and burning; 2. By its absence in the morning, and increase during the exertion of the day; 3. By its seat in some one muscle, and being increased by the movement of that muscle; 4. It is the result of unusual exertion of the muscle; 5. It is relieved by relaxation, or artificial support; 6. The pulse is unaffected; 7. The pain of cramp often comes on suddenly during the night. The distinction between myalgia and neuralgia is of importance, as the treatment of the two diseases might be directly opposite.

With regard to the treatment of neuralgia, it would appear quite superfluous to say that it must be regulated by the circumstances of each particular case, if it were not notorious that no disease has been treated more blindly and empirically. When any foreign body presses upon the nerve, or when the pain can be distinctly traced to a carious tooth, the removal of the source of irritation will commonly be sufficient to cure the disease, though the practitioner should be especially warned against the danger of confounding neuralgia with the tooth-ache—an error that is not unlikely to occur in some cases of tic douloureux, and one that has often occasioned the loss of several teeth to the patient without any good effect. When (as is sometimes the case) the disease appears to be occasioned by the irritation arising from an old cicatrix, it will be expedient to try the effect of applications to the cicatrix itself—namely, either the nitrate of silver, or the actual cautery, or a blister, or a crucial incision over the part, or even its removal by the knife. And in the same way, when it can be distinctly referred to any other of the exciting causes enumerated above, the removal of that will probably be followed by the disappearance of the disease. But, as already observed, it very frequently happens that the exciting cause cannot be discovered, and in these cases the treatment must necessarily be in a great degree empirical. When the paroxysms are irregular in their duration and recurrence, perhaps the sesquioxide of iron is the best remedy at present known: it may be given in doses of half a drachm three times a day in twice its weight of treacle. When the pain recurs after certain regular intervals, those medicines which are found to be most efficacious in the treatment of ague may be exhibited with advantage. The disulphate of quina may be given in doses of four or five grains three times a day, though this medicine has sometimes been given in much larger quantities, and Sir Benjamin Brodie mentions one case where the patient took as much as half a drachm daily. ('Local Nervous Affections,' p. 28.) The liquor potassæ arsenitis is another excellent medicine which may be employed in this form of disease: the dose is at the commencement four or five minims three times a day, which may gradually and cautiously be increased to ten or fifteen. When there are any signs of inflammation present, that the disease may seem rather to deserve the name of neuritis than of neuralgia, it must be treated accordingly, and the usual antiphlogistic remedies, both external and internal, may be employed. In almost every case of neuralgia it will be advisable to exhibit some preparation of opium, both to relieve the pain and also in order to procure the patient some sleep at night, at which time the paroxysms are often much aggravated; and especial care must also be taken not only to prevent the constipation caused by this drug, but also to keep up a free evacuation of the bowels, as in some cases the disease appears to have been cured by purgative medicines alone.

Among local applications may be mentioned the unguentum veratri, emplastrum opii, and empl. belladonnæ, or a lotion (recommended by Dr. Bennett, of Charleston in America), composed of four ounces of the aqua laurocerasi and one ounce of sulphuric ether, either alone or with half or one drachm of the extract of belladonna. The application of an ointment with one or two grains of aconitina to a drachm of lard has also been strongly recommended. Counter-irritants have often proved very efficacious, particularly the application of a common blister, and, after the cuticle has been removed, the sprinkling over the denuded surface a quarter or half a grain of the acetate or hydrochlorate of morphia. Moxas and issues have also been tried with success. [Issue; Moxa.]

After all other remedies, both internal and external, have failed, the patient's last resource is the operation either of dividing the nerve or removing the limb; and even this will very often fail also. When the disease depends on some local irritation, or resides in the extremity of the nerve, the operation is frequently successful; but when it proceeds from constitutional causes, or exists either in the brain itself or nearer to it than the point where the nerve can be divided, in this case it is manifest that, as no benefit can reasonably be expected from the operation, the experiment ought never to be tried but at the earnest request of the patient. Sometimes the nerve is simply divided; but in these cases the pain very often returns as soon as the two extremities are re-united. Sometimes a portion of the nerve is removed; but even this appears only to obtain for the patient rather a longer respite. Latterly, after part of the nerve has been cut away, the two ends have been touched either with nitrate of silver or the actual cautery, and in some instances this plan appears to have succeeded where the simple section of the nerve had failed.

(Cooper's *Dictionary of Practical Surgery;* Good's *Study of Medicine;* Dr. Elliotson, in the *Cyclopædia of Practical Medicine;* Franck, *Praxeos Medicæ Universæ Præcepta,* t. iv.; M. Jolly, *Dictionnaire de Médecine et de Chirurgie Practiques,* t. xii.; Sir Benjamin Brodie, *On Local Nervous Affections,* 8vo, Lond., 1837; Dr. Rowland, *Treatise on Neuralgia,* 8vo, Lond., 1838; Watson, *Lectures on the Practice of Physic;* Romberg, *On Diseases of the Nervous System;* Inman, *On Spinal Irritation.*)

NEURITIS. [Neuralgia.]

NEUTER. [Gender.]

NEUTRAL AXIS. The neutral axis of a loaded body is an imaginary line, separating those portions of the body which are exposed to the action of opposite forces; as for instance, in the cases of girders, or occasionally of columns, there are some laminæ which are exposed to compression, and others which are exposed to become extended, whilst there are laminæ about which those forces of compression and extension are balanced in such a manner as to leave them in a neutral state, so long as the conditions of elasticity of the affected portions are not permanently injured. It had long been known, and has recently been proved by the investigations of Mr. E. Hodgkinson, that every body, or substance, used in the mechanical operations of building, or of machinery, has its own peculiar laws of elasticity; and it therefore follows that the position of the neutral axis in any of them must vary in an almost endless variety of manners, according to the shape of the particular body experimented upon, or to its physical properties. Thus wood has been ascertained to resist efforts of compression in nearly the same manner that it resists efforts of extension; whereas, cast iron resists the former class of efforts with a far greater degree of energy than it does the latter class; and wrought iron, again, is known to compress under smaller efforts than are required to extend it. Under these circumstances, the position of the neutral axis would vary in beams of either of those materials, if the same form of section be employed; or, in case it should be required to cause the neutral axis to pass through the same points, it would be necessary to change the form of the body, so as to bring into play the peculiar elastic properties it may possess in such a manner as to allow the sum of the resistances to contraction and expansion to balance one another on either side of the line of the immovable fibres. In rectangular beams of materials of an equal degree of elasticity under any description of effort, that is to say, under efforts either of compression or of extension, the neutral axis will be found to pass through the centre of gravity of the loaded beam; and in all cases the ratio of the moments of the material undergoing compression and extension about the neutral axis must be made equal to the ratio of the forces of extension and compression to secure stability. [Resistance.]

NEUTRAL SALTS. [Salts.]

NEUTRALISATION. In chemistry the operation of adding an acid to an alkaline solution, or vice versâ, an alkali to an acid liquid, until the latter neither reddens blue litmus paper nor browns turmeric paper. Such a liquid is then said to be *neutral* or to possess a *neutral re-action.*

NEUTRIA. [Furriery.]

NEW TESTAMENT. [Testament, Old and New.]

NEW-YEAR'S-DAY. Of the customs formerly practised at the opening of the new-year, none appear to have been so universal as feasting and sending presents, both of which the moderns appear to have derived from the Romans. Suetonius ('August.' § 57, edit. varior., 8vo, 1647) alludes to the practice among the Romans of bringing presents to the Capitol on new-year's-day, whether the emperor was present or absent; and Tacitus speaks of an order of Tiberius, forbidding the giving or demanding of new-year's-gifts unless it were on the calends of January. The early fathers of the church condemned this practice as superstitious, because the gifts were considered as omens of success for the ensuing year.

New-year's-day with us, like many others, in modern times, has lost much of the ceremonials of its observance. In a volume of 'Miscellanies,' printed in Queen Anne's time, we read,—"January. On the first day of this month will be given many more gifts than will be kindly received or gratefully rewarded. Children, to their inexpressible joy, will be drest up in their best bibs and aprons, and may be seen handed along streets, some bearing Kentish pippins, others oranges stuck with cloves, in order to gain a blessing of their godfathers and godmothers."

Gifts at new-year's-tide formed a charge of no small amount in the privy-purse expenses of royalty, from very early times to the time of Charles II.; they were mostly made in plate.

Moresin, who published his 'Papatus' in the time of James I., tells that in Scotland it was then the custom to *send* new-year's-gifts on new-year's-eve; and on new-year's-day they wished each other a happy day, and *asked* a new-year's-gift. When Brand wrote his 'Popular Antiquities,' it was still usual in Northumberland for persons to ask for a new-year's-gift on that day. The practice of "first-footing," in Scotland, is now dying out before the advance of temperance and education.

In France the custom of giving new-year's-gifts is still kept up, to such an extent as to make a vast addition to the business of the great towns in the articles usually selected for presents.

The modern Jews, on the first day of the month Tisri, which may be considered as their new-year's-day, usually have a splendid entertainment, and wish each other a happy new year.

Hospinian says, that at Rome on new-year's-day (he speaks of modern practices) no one would suffer a neighbour to take fire out of his house, or anything of iron, or lend anything. (Brand's 'Popular Antiq.')

New-year's-eve was celebrated by hospitality and drinking, seeing the old year out and the new-year in; the church bells were rung as the clock struck twelve. But these customs are disappearing like the others, although as yet the bell ringing is by no means uncommon. A midnight mass is now, we believe, held in most Roman Catholic places of worship in England; and a midnight service in many churches of the Establishment. Religious services, termed a "watch night," are also commonly conducted on New Year's eve, closing at a few minutes past twelve, in Wesleyan Methodist chapels, and by many Dissenters.

NEWSPAPERS. Some persons are of opinion that the origin of newspapers may be traced to the 'Acta Diurna' of the Romans. [Acta Diurna.] However this may be, it was not till the 16th century that anything at all approaching to the nature of the 'Acta Diurna' existed in modern times. The war which the republic of Venice waged against the Turks in Dalmatia gave rise, in 1563, to the custom in Venice of communicating military and commercial news by written sheets, which were read in a particular place to those desirous to hear them, and who paid for this privilege in a coin no longer in use, called *gazzetta,* a name which, by degrees, was transferred to the newspaper itself in Italy and France, and passed over into England. The Venetian government eventually gave these announcements in a regular manner once a month; but they were too jealous to allow them to be printed. Only a few written copies were transmitted to various places, and read to those who paid to hear. Many volumes of these manuscript newspapers exist in the Magliabecchian library at Florence.

For some time it was supposed that English newspapers were first established in the reign of Elizabeth, founded on the existence of three papers, numbered 50, 51, and 54, preserved in Dr. Birch's '*Historical* Collections' in the British Museum, and imagined to belong to a series. But they were suspected not to be genuine. The suspicion was well founded. In 1839 Mr. Thomas Watts, one of the librarians of the British Museum, published a 'Letter to Antonio Panizzi, Esq.,' in which he proved incontrovertibly that they were forgeries, and that the forgery was perpetrated about 1766. The three numbers, which are marked as 50, 51, and 54, purporting them to be part of a series, contain seven articles, three of which are in print and four in manuscript. The type is of the date of 1766, but an old style of spelling is affected, while in the manuscript the spelling is modern, with a number of corrections in a different hand-writing; and the manuscript is written on a paper with the water-mark of the royal arms and initials of "*G. R.*" In 1850 Mr. Watts made public the result of his further investigations, which showed that the manuscript was in the hand-writing of Philip Yorke, the second earl of Hardwicke, and a few of the corrections in that of Dr. Birch. Mr. Watts also proved that the claims of France for the earliest newspaper, the 'Gazette of Paris,' in 1631, are also unfounded, and that the earliest specimen of this branch of literature belongs "to Italy or to Germany." The claim of Germany is strongest: at Augsburg and Vienna printed sheets containing news were published as early as 1524.

In the reign of James I., packets of news were published in the shape of small quarto pamphlets occasionally. The earliest we have met with, preserved in the second volume of the series of newspapers purchased with Dr. Burney's library (also in the British Museum), is entitled 'News out of Holland,' published in 1619 for N. Newbery, followed by other papers of news from different countries in 1620, 1621, and 1622. There can be no doubt of the genuineness of these. In 1622, when the Thirty Years' War and the exploits of Gustavus Adolphus excited curiosity, these occasional pamphlets were converted into a regular weekly publication, entitled 'The News of the Present

Week,' edited by Nathaniel Butler. This seems to have been the first weekly newspaper in England.*

About this period newspapers began also to be established on the Continent. Their originator at Paris is said to have been one Renaudot, a physician, who had found that it was conducive to success in his profession to be able to tell his patients the news. Seasons were not always sickly, but his taste for collecting news was always the same, and he began to think that there might be some advantage in printing his intelligence periodically. His scheme succeeded, and he obtained a privilege for publishing news in 1632. It would appear that not long after this time there were more newspapers than one in England.

Upon the breaking out of the civil war in Charles I.'s time, great numbers of newspapers, which had hitherto been chiefly confined to foreign intelligence, were spread abroad by the different parties into which the state was then divided, under the titles of 'Diurnals,' 'Special Passages,' 'Intelligencers,' 'Mercuries,' &c., mostly in the size of small quarto, and treating of domestic matters. Nearly a score are said to have come out in 1643, when the war was at its height. Heylin, in the address prefixed to his 'Cosmographie,' enjoins the reader not to think himself unsatisfied in his expectation, if he find not in it "the situation and affairs of each town of war or the quartering-place of every company or troop of soldiers, which are presented to him in the weekly news-books." Hence we find some papers entitled 'News from Hull,' 'News from the North,' 'The last-printed News from Chichester, Windsor, Winchester, Chester,' &c., and others too numerous to mention. We also find 'The Scots Dove' opposed to 'The Parliament Kite,' or 'The Secret Owl.' Keener animosities, as Disraeli remarks, produced keener titles: 'Heraclitus Ridens' was met by 'Democritus Ridens,' and 'The Weekly Discoverer' was shortly met by 'The Discoverer Stript Naked.' 'Mercurius Britannicus' was grappled by 'Mercurius Mastix faithfully lashing all Scouts, Mercuries, Posts, Spies, and others.' Mercurius was the favourite name, with another word to indicate the character of the party from whom it emanated. Whenever any title however grew popular, it was stolen by the antagonist, who thus conveyed his opinions to those who would not have received them had he not worn the appearance of a friend.

Disraeli, in his 'Curiosities of Literature,' gives an account of the two principal persons who were at this time concerned in the newspaper press, Marchant Needham and Sir John Birkenhout. "Marchant Needham," he says, "the great patriarch of newspaper writers, was a man of versatile talents and more versatile politics, a bold adventurer, and most successful because the most profligate of his tribe. From college he came to London; was an usher in Merchant Taylors' School; then an under-clerk in Gray's Inn; at length studied physic and practised chemistry; and finally he was a captain, and, in the words of honest Antony à Wood, 'siding with the rout and scum of the people, he made them weekly sport by railing at all that was noble in his intelligence, called Mercurius Britannicus, wherein his endeavours were to sacrifice the fame of some lord, or any person of quality, and of the king himself, to the beast with many heads.' He soon became popular, and was known under the name of Captain Needham of Gray's Inn; and whatever he now wrote was deemed oracular. But whether from a slight imprisonment for aspersing Charles I., or some pique with his own party, he requested an audience on his knees with the king, reconciled himself to his majesty, and showed himself a violent royalist in his 'Mercurius Pragmaticus,' and galled the Presbyterians with his wit and quips. Some time after, when the popular party prevailed, he was still further enlightened, and was got over by President Bradshaw as easily as by Charles I. Our Mercurial writer became once more a virulent Presbyterian, and lashed the Royalists outrageously in his 'Mercurius Politicus.' At length, on the return of Charles II., being now conscious, says our friend Antony, that he might be in danger of the halter, once more he is said to have fled into Holland, waiting for an act of oblivion. For money given to a hungry courtier, Needham obtained his pardon under the great seal. He latterly practised as a physician among his party, but lived universally hated by the Royalists, and now only committed harmless treasons with the College of Physicians, on whom he poured all that gall and vinegar which the government had suppressed from flowing through its natural channel." In buffoonery, keenness, and boldness, Sir John Birkenhout, the other principal news-writer of the day, was not inferior, nor was he at times less an adventurer, than Needham. His 'Mercurius Aulicus' was devoted to the court, then at Oxford. Beside newspapers, he was the author of numerous small political pamphlets abounding in wit and satire.

In 1662 the 'Kingdom's Intelligencer' was commenced in London, which contained a greater variety of useful information than any of its predecessors. It had a sort of obituary, notices of proceedings in parliament and in the law courts, &c. Some curious advertisements also appear in its columns. In 1663 another paper, called 'The Intelligencer, published for the satisfaction and information of the people,' was started by Roger (afterwards Sir Roger) L'Estrange, who warmly espoused the cause of the crown on all occasions, and infused into his newspapers more information, more entertainment, and more advertisements of importance than were contained in any succeeding paper whatever previous to the reign of Anne. L'Estrange continued his journal for two years, but dropped it upon the appearance of the 'London Gazette,' first called the 'Oxford Gazette,' owing to the earlier numbers being issued at Oxford, where the court was then holding and the parliament sitting, on account of the plague being in London. The first number of what has still continued to the present time as the 'London Gazette' was published at Oxford, February 4th, 1665. So numerous did these little *books of news*, as they were called, become at this time, that between the years 1661 and 1668 no less than seventy of them were published under various titles.

On the 12th of May, 1680, L'Estrange, who had then started a second paper, called the 'Observator,' first exercised his authority as licenser of the press, by procuring to be issued a "proclamation for suppressing the printing and publishing unlicensed news-books and pamphlets of news, because it has become a common practice for evil-disposed persons to vend to his majesty's people all the idle and malicious reports that they could collect or invent, contrary to law; the continuance whereof would in a short time endanger the peace of the kingdom; the same manifestly tending thereto, as has been declared by all his majesty's subjects unanimously." The charge for inserting advertisements (then untaxed) at this period, we learn from the 'Jockey's Intelligencer,' 1683, to be "a shilling for a horse or coach, for notification, and sixpence for renewing;" also in the 'Observator Reformed,' it is announced that advertisements of eight lines are inserted for one shilling; and Morphew's 'Country Gentleman's Courant,' two years afterwards, says, that "seeing promotion of trade is a matter that ought to be encouraged, the price of advertisements is advanced to two pence per line." The publishers at this time, however, were sometimes puzzled for news to fill their sheets, small as they were; but a few of them got over the difficulty in a sufficiently ingenious manner. The 'Flying Post,' in 1695, announces, that "if any gentleman has a mind to oblige his country friend or correspondent with this account of public affairs, he may have it for two-pence of J. Salisbury, at the Rising Sun in Cornhill, on a sheet of fine paper, *half of which being blank*, he may thereon write his own private business, or the material news of the day." Again, 'Dawker's News-Letter:' "This Letter will be done upon good writing-paper, and blank space left, that any gentleman may write his own private business. It will be useful to improve the younger sort in writing a curious hand." Another publisher had recourse to an expedient for filling his sheet, curious enough: wherever there was a dearth of news, he filled up the blank part with a sufficient proportion from the Bible.

It was not until the reign of Anne that the Londoners enjoyed the luxury of a newspaper every day. The first was issued in 1709, and called 'The Daily Courant,' being published every day but Sunday. There were at this time seventeen others published thrice a week, and one twice. Among them was the 'British Apollo,' the 'General Postscript,' the 'London Gazette,' the 'Postman,' the 'Evening Post,' and the 'City Intelligencer.'

It was about this time that a new species of publication came out, which, although it would scarcely be regarded as belonging to the family of newspapers now, was held to be so then; and, in fact, for a considerable time after it was commenced, it included articles of news along with its other matter. We allude to those admirable publications, the 'Tatler,' 'Spectator,' 'Guardian,' &c., which formed the models of so many subsequent publications of the same kind. The first number of the 'Tatler' was published on the 23rd of April, new style, 1709; the last on the 2nd of January, 1711. Much space was occupied in each by advertisements, and the price of each number was a penny. The publication of the 'Spectator' began March 1, 1711, at the same price; but upon the imposition of the half-penny stamp-duty, which began August 1, 1712, the price was raised to two-pence. The halfpenny tax is conjectured to have been the cause of the 'Spectator' being stopped in the beginning of 1713. It was however immediately followed by the 'Guardian,' the first number of which appeared on March 2nd, 1713. This paper soon dropped, and was succeeded by the 'Englishman' in October the same year (professedly political). The 'Englishman' lasted for two years, and was in its turn supplanted by the 'Freeholder,' on December 23rd, 1715, the latter work being almost the sole production of Addison.

It may be sufficient to notice in few words two or three of the more remarkable journals only which have since succeeded. The 'Public Advertiser' was first printed under the title of the 'London Daily Post and General Advertiser,' so far back as 1726, and assumed its later name only in 1752. This paper was the vehicle through which 'Junius's Letters' were given to the world. The 'St. James's Chronicle' is another of our oldest papers; at its first publication it was an amalgamation of two papers (the 'St. James's Post' and the 'St. James's Evening Post'), both of which began in 1715. The 'North Briton,' edited by Wilkes, first appeared in 1762; and in the same year the 'Englishman' was established. The 'Englishman' attracted much notice about 1766, on account of the insertion of

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* Before the introduction of printed newspapers, it appears that great families had a sort of gazetters in London, who transmitted to them the news of the day in written letters. This custom accounts for the following memorandum preserved in the Clifford family: "To Captain Robinson, by my lord's commands, for writing letters of news to his lordship for half a year, five pounds." (Whitaker's 'Hist. of Craven.')

By the Act 18 & 19 Vict., cap. 27, any periodical publication, published at intervals, not exceeding thirty-one days, of which the print does not exceed the prescribed superficies, may claim to be stamped as a newspaper; but in such case the title must be printed on the top of every page, with the date of publication; and, when posted, must be folded so as to show the stamp denoting the duty. Newspapers to be sent abroad by post may be registered at the General Post-office, for which an annual fee of 5*s.* is charged, the year always terminating on the 30th of June. It is not absolutely necessary that the newspaper should be registered, but the English Post-office then charges 2*d.* in addition to the foreign or colonial postage. Before a newspaper can be published a notice must be given at the Inland Revenue Office, Somerset House, or at the District Stamp-office, where the form of a "declaration" will be given, in which is to be stated—the title of the intended paper, quoted literally; the place where it is to be printed, giving the number of the house, the name of the street and of the parish in which it is situated, and the name of the occupier if it forms part of a dwelling-house; and the like particulars respecting the place of publication if it differs from the place of printing; the Christian and surnames of the printers and publishers; the number of shares into which the property is divided whenever the number, exclusive of the printer and publisher, exceeds two; and the Christian and surnames, residences, and occupations, of every proprietor, with the number of shares belonging to each when exceeding two, exclusive of the printer and publisher. This declaration must be made by the proprietor, or two proprietors, or by two of the largest shareholders where the number exceeds two, who must also furnish two respectable householders as sureties against the publication of seditious, blasphemous, or personal libels, to the amount of 400*l.* in London and 300*l.* elsewhere. A newspaper published before these securities are given subjects the proprietors to a penalty of 20*l.* The paper when published must have across the bottom of the last page or the last column, the names and residences of the printer and publisher, the place of publication, the date, and the price, under a similar penalty for neglect. A supplement must not be issued without the paper itself; and a copy of the paper, which is paid for, must be transmitted to the Stamp-office on the day of publication or the day after in London, Edinburgh, or Dublin, and elsewhere within three days, under the like penalty of 20*l.* for each offence; but the penalties can only be sued for by the Attorney-General or the Stamp-office.

The size and amount of stamp-duty for newspapers are defined as follows by the 16 & 17 Vict., cap. 63:—Newspaper stamps are to be 1*d.* only, for a superficies of print, on one side of the paper, not exceeding 2295 inches, whether published as a supplement or not; any supplement that with the paper does not exceed that quantity is to be exempt; and any other supplement to a duly stamped newspaper not containing a superficies on one side of more than 1148 inches of print is to be subject to a stamp of one halfpenny; and any two supplements not containing more than 2296 inches, to a duty of one halfpenny each, provided each be published on one sheet of paper only. Newspapers not stamped go by post at the book-post rate of a penny for 4 ounces, twopence for 8 ounces, and then ascending by twopence for every fraction of 8 ounces; and any number may be sent in one envelope open at the ends.

The largest collection of newspapers in England is in the British Museum. This collection was commenced by a considerable number being sent there, at the time when the Museum was established, with the library of Sir Hans Sloane. Another collection, of itself valued at 1000*l.*, was purchased in 1818 with the library of the late Dr. Charles Burney. At the end of two or three years from the time of publication the commissioners of stamps now transfer to the British Museum, for public use, copies of all the stamped newspapers, both of town and country.

In Germany newspapers originated in the 'Relations,' as they were termed, which sprung up at Augsburg and Vienna in 1524, at Ratisbon in 1528, at Dillingen in 1569, and at Nürnberg in 1571, and which appeared in the form of letters printed, but without date, place, or number. The first German newspaper in numbered sheets was printed in 1612. Italian journals were also early, and France has many newspapers, both in Paris and the provinces, but they were started under the protection of the government, and have never been long free from government control. At present all are liable to warnings for any infraction of prescribed rules, involving suspension and ultimate suppression, a power that has been very freely exercised. Every civilised country has now its newspapers; and in the founding of an English or American settlement, the newspaper is among the first establishments.

In the United States the increase of newspapers has been more rapid than in England. In the year 1704, the first Anglo-American newspaper, called the 'Boston News Letter,' was published at Boston. In 1719 the first newspaper was published in Pennsylvania; and in 1783 the first newspapers were published in New York and Rhode Island. Now there is hardly a petty town in any of the twenty-six states without its newspaper, and in the large cities, such as New York, several are published daily. At the Census of 1850, as far as returns were made, there were 254 daily papers published in the United States; 115 "tri-weekly;" 31 "semi-weekly;" and 1902 weekly. Among these nearly 50 papers were published in the German language; about a dozen in French; several in Spanish, Italian, &c. In Pennsylvania a considerable number of newspapers are printed in the German language, and distributed among the numerous German settlers in that state. One German newspaper at least is also published in Maryland, and perhaps more. In Louisiana, some papers are printed both in French and English.

NEWTON'S PRINCIPIA. [Principia.]

NEXT OF KIN. [Consanguinity; Intestacy.]

NICE, COUNCIL OF. [Council, of the Church.]

NICENE CREED, THE, is one of the three creeds received by the church of England. It consists of the creed drawn up by the first council of Nice, with the addition of that part which relates to the divinity of the Holy Ghost. It was adopted in its present shape at the second general council of Constantinople, A.D. 381.

NICHE (from the Italian *nicchia*, signifying also a nook), a small recess, or concavity in the face of a wall for the purpose of containing a statue. The Greeks rarely employed statues as external decorations to their edifices, sculpture being so applied by them only as friezes, or within pediments, and they did not therefore require niches. In Roman architecture, on the contrary, niches are of very frequent occurrence, and often enter very largely into a design as principal features in the composition. Niches are usually semicircular in plan, and round-headed, that is, covered by the quarter of a hollow sphere, owing to which the shadow within the concavity produces a beautiful curve. They are, however, occasionally made square in plan, in which case they are square-headed; but square-headed niches are sometimes made circular in plan, though round-headed ones are never square. Niches exhibit still greater diversity in the modes of decorating them; and they are sometimes left quite plain, and in this country, oftener than not, quite empty also; although a niche without a statue, vase, or some piece of sculpture in it, is a very questionable feature, suggesting to the spectator the absence of the object which it is intended to receive. When niches are decorated they are usually placed within a square-headed panel, having architraves and other dressings like those of windows, and therefore admit of as much variety of design as windows themselves. Many architects have given them columns, and thus converted them into small tabernacles (as in the upper order of the side elevations of St. Paul's), or have otherwise bestowed so much enrichment upon them that the statues within them are almost lost.

In Romanesque and Pointed Gothic architecture, niches are largely employed, and rendered a highly ornamental feature. In our own country we find them extensively used through every period, but varying in character in each. When employed in the Norman period they are mere shallow recesses, and but slightly ornamented. Sometimes they occur in a series under intersecting arches. In the First Pointed style they are more frequent, more deeply recessed, more ornamented, the sides have handsome mouldings, the heads have trefoil or cinquefoil cusps, and frequently they have a flat or projecting canopy. [Canopy.] Sometimes the figures are set on low pedestals: good examples occur at Salisbury, Peterborough, and Wells Cathedrals, and of the transition to the Second Pointed period at Beverley Minster. In the Second Pointed, or Decorated style, still more regard is paid to the niches, which are now much more varied in character, and often highly elaborated. The top is frequently carved to imitate regular vaulting, the canopies are very various in form and decoration, but usually pedimental or ogee, projecting, and often ornamented with crockets, pinnacles, and a fully developed finial. Niches in this style often occur in buttresses, on the sides of doorways as at Rochester Cathedral, and on each side of the east window. The figures are usually placed on richly carved brackets. Good examples occur at Wells, Lichfield, Ely, and Rochester Cathedrals, and York and Beverley Minsters. In the Third Pointed, or Perpendicular style, niches are even more abundant, and in ornament more exuberant, the canopies often running upwards into small spires, and pinnacles, crockets, and finials being very profusely employed. The top is often groined, and has sculptured bosses. They may be seen in all important buildings of this style, but it will perhaps be enough to refer to Henry VII.'s chapel, and the very numerous and elaborate modern examples, all imitated from the best old examples, in the New Palace, Westminster.

The sedilias, piscinas, stoups, and other recessed features of Gothic ecclesiastical buildings, are usually so treated as to be in fact niches, though having their proper names they are not so classed.

NICKEL (Ni). A well known elementary metal. It is extensively used in the manufacture of the so-called *nickel-silver*, German-silver, and similar white alloys. Its natural history and physical properties together with the source and composition of its ores have already been described. [Nickel, in Nat. Hist. Div.] A method of reducing nickel from its natural combinations has also been given, but on account of the increasing demand for it, greater attention has of late years been paid to the metallurgy of this metal, and the following process is, according to Louyet, the one now generally adopted in Birmingham. Speiss, an arsenio-sulphide of nickel and other metals, obtained in the manufacture of smalt [Cobalt], is first fused with chalk and fluor spar and the resulting metallic mass reduced to powder and roasted to expel arsenic; the residue is then treated with hydrochloric acid, and bleaching powder gradually added to the solution till the iron is peroxidised. Milk of lime being now cautiously poured in the iron is thrown down as peroxide, any traces of arsenic being carried down with it; the clear liquid is treated with a current of sulphuretted hydrogen to precipitate copper, bismuth, and lead, and the cobalt got rid of as peroxide by a second addition of solution of bleaching powder. Finally the nickel is precipitated as hydrated oxide by adding sufficient milk of lime, and the metal obtained on strongly heating, in a wind furnace, a mixture of black flux and the dried oxide.

The equivalent of nickel is 29·54 and its specific gravity, 8·82.

Oxygen and Nickel combine in two proportions, forming the protoxide and sesqui-oxide or peroxide.

Protoxide of Nickel (NiO) may be obtained by adding potash or soda to a solution of any salt of nickel, by which a green hydrate (NiO, HO) is precipitated; this, heated to redness, loses water and becomes of a dark olive-green colour. It may also be procured by heating nitrate of nickel to redness. It is insoluble in water, readily dissolved by most acids, and yields green solutions. It is not reducible to the metallic state by heat alone, and is not attracted by the magnet. When fused with borax a hyacinth-yellow bead is produced, becoming lighter in colour on cooling. Oxide of nickel is insoluble in potash or soda, but readily dissolves in ammonia; the solution has a fine azure-blue colour, and is decomposed by potash or soda. It is the base of all the salts of nickel.

Peroxide of Nickel (Ni_2O_3) may be obtained by adding a solution of chloride (hypochlorite) of soda to one of nitrate of nickel, or by transmitting chlorine gas through water in which hydrate of nickel is suspended. The peroxide thus obtained is of a black colour, insoluble in dilute acids, potash, or soda. When added to a mixture of ammonia and its carbonate, nitrogen gas is evolved, and the peroxide, becoming protoxide, is dissolved. With hydrochloric acid it gives out chlorine gas, and forms chloride of nickel. At a red heat it yields oxygen gas.

Chloride of Nickel ($NiCl$) is formed by dissolving either the protoxide or peroxide of the metal in hydrochloric acid. Its colour is a fine emerald-green; and by evaporating the solution, green filamentous crystals containing water are formed. This salt deliquesces in a moist atmosphere. When deprived of water it has a yellow colour and a micaceous appearance; it is volatile, and when sublimed at a high temperature is obtained in beautiful golden-yellow crystalline scales. Its solution is decomposed by the alkalies and their carbonates, but ammonia added in excess redissolves the precipitate at first formed.

The *fluoride* ($NiFl$), *bromide* ($NiBr$), and *iodide of nickel* (NiI), are of but little importance. The bromide and iodide form hydrated salts containing six equivalents of water.

Sulphur and Nickel combine in three proportions, forming the sulphide, disulphide, and bisulphide.

Sulphide of Nickel (NiS) is prepared either by heating metallic nickel or the oxide with sulphur; or it may be procured by adding a hydrosulphate to a solution of nickel. The precipitated sulphide is nearly black, and dissolves in hydrochloric acid with the evolution of hydrosulphuric acid gas; the sulphide procured in the dry way is of a grayish-yellow colour, and requires aqua regia (or nascent chlorine) for solution. Sulphide of nickel is also found native. [NICKEL, in NAT. HIST. DIV.]

Disulphide of Nickel (Ni_2S) may be prepared by transmitting hydrogen gas over sulphate of nickel at a red heat. Its colour is lighter, and it is more fusible than the sulphide.

Bisulphide of Nickel (NiS_2). Carbonate of nickel is strongly ignited with sulphur and carbonate of potash, and the residue well washed with water. It is soft to the touch, and of dark iron-gray colour.

Phosphide of Nickel (NiP) is formed by the action of phosphorus upon nickel heated to redness; the resulting compound is whitish, brittle, and is decomposed when exposed to heat and air. It is more fusible than the metal, and, and according to Pelletier, is composed of 17 phosphorus + 83 nickel; while Lampadius states its composition to be 18 phosphorus + 87 nickel.

Cyanide of Nickel ($NiCy$) is prepared by adding a soluble cyanide to a solution of nickel, or when hydrocyanic acid is mixed with acetate of nickel.

Ferrocyanide of Nickel is a grayish or greenish compouud, which is precipitated when ferrocyanide of potassium is added to the salts of nickel. The *ferricyanide* is yellowish green.

Nitrate of Nickel (NiO, NO_5) may be prepared by dissolving either the metal or its oxide in dilute nitric acid. The solution is of a fine green colour, and by evaporation yields a deliquescent salt, containing six equivalents of water of crystallisation.

Sulphate of Nickel ($NiO, SO_3 + 7Aq.$) is easily procured by dissolving the oxide or hydrate in dilute sulphuric acid; a green salt is obtained, which readily crystallises in two different primary forms; first in rhombic prisms, and then by exposure to light in regular octohedra, the original crystals becoming opaque but retaining their prismatic outline. A *double sulphate of potash and nickel* ($NiO, SO_3 + KO SO_3 + 6Aq$) readily crystallises out on evaporating a solution of the mixed sulphates.

The *carbonates of nickel* are mostly basic, containing variable proportions of hydrated oxide. They are precipitated when an alkaline carbonate is added to a solution of nitrate, or other salt, of nickel.

Alloys of Nickel:—

Arsenic readily combines with *Nickel*, and the compound remains undecomposed at a very high temperature. It does not obey the magnet.

Potassium and Nickel combine by fusion.

Antimony and Nickel form an alloy of a lead-colour.

Zinc and Nickel form a white brittle alloy, which enters into the composition of the *packfong* of the Chinese.

Tin and Nickel give rise to a white brittle alloy, which burns at a high temperature.

Cobalt and Nickel readily fuse together.

Mercury and Nickel have not been combined.

Copper, Zinc, and Nickel form a white alloy, of late years much employed under the name of GERMAN SILVER.

Iron and Nickel occur associated in meteoric stones. The following table exhibits the centesimal amounts of the two metals in some well authenticated specimens.

	1.	2.	3.	4.	5.
Iron . .	66·56	88·04	85·61	89·12	93·78
Nickel .	24·71	10·73	12·28	8·26	3·81

1. From Clairborne in Alabama. 2. The Pallas meteoric iron from Siberia. 3. From Cap; specific gravity, 7·665. 4. From Levarto; specific gravity, 7·798. 5. From Bohumilitz in Bohemia.

Tests for nickel. The solutions of nickel salts have a rich green colour. They are distinguished by giving—no precipitate with sulphuretted hydrogen; black with sulphide of ammonium; green with a caustic alkali, not altering on exposure to air; and green with ammonia, forming in excess a bright blue solution.

Estimation of nickel. This is generally performed in the state of protoxide, which contains 78·69 per cent. of metal. It is precipitated from solution by potash, and must be many times washed with hot water to thoroughly remove all the alkali. According to Field, nickel is best precipitated as peroxide. The solution is boiled with hypochlorite of soda in a beaker, care being taken to prevent the peroxide attaching itself to the sides of the vessel. This precipitate is easily washed, and on ignition to whiteness is reduced to protoxide, and may in that state be weighed. Liebig separates nickel from cobalt by boiling the solution of their potassio-cyanides with finely levigated peroxide of mercury; the nickel salt is then decomposed and the hydrated oxide of that metal precipitated, while the cobalticyanide of potassium remains in solution along with cyanide of mercury.

NICKEL SILVER. [NICKEL, *Alloys of*.]

NICOLA'ITANS, a sect of heretics, who arose in the 1st century, and are mentioned with strong disapprobation in Rev. ii. 6, 15. They appear, from the statements of the early writers, to have held the doctrines of the Gnostics, and to have lived impurely. It is generally supposed that "the doctrine of the Nicolaitans" (Rev. ii. 15) is the same as "the doctrine of Balaam" (v. 14), namely, "to eat things sacrificed to idols, and to commit fornication." Indeed some critics suppose the name Νικόλαος in this passage to be merely translated from בִּלְעָם and used symbollically, deriving the former word from νικάω and λαός, and the latter from the synonymous Hebrew words בָּלַע and עָם. (Robinson's 'Greek Lexicon to the New Testament.') The early writers trace this sect to Nicolas the Deacon (Acts vi. 5), but some of them acquit him of holding the sentiments of the Nicolaitans, and ascribe the rise of the heresy to an improper advantage taken of some incautious expressions which he had used.

(Mosheim's *Eccl. Hist.*; Winer's *Biblisches Realwörterbuch*; Neander's *Kirchengeschichte.*)

NICOTIA. [NICOTINE.]

NICOTIA'NA TABA'CUM, an annual plant, of which the leaves are used in a variety of forms and ways, and also in medicine. The dried leaves are large, long, entire, smooth, somewhat glutinous, and of a brown colour, with a peculiar stupifying odour, and an acrid, nauseous, bitter taste. The processes of maceration and partial fermentation, and admixture of different substances, render it more agreeable in the dried than in the fresh state. The analysis of tobacco shows its chief ingredients to be:—1st, a tobacco-camphor, called nicotian, or nicotianin, which crystallises, and is solid at the ordinary temperature of the air; has a faint odour of tobacco, with a warm, bitterish aromatic, but not acrid taste, and is not possessed of any narcotic power; if applied to the nostrils, it causes sneezing; and if a grain be taken into the stomach, it creates uneasiness and giddiness. It is called by some the acid principle of tobacco, and if such be its nature, it is most probably combined in the herb with, 2nd, nicotina, an alkaloid, which, like conia, does not exist at ordinary temperatures in a solid form, but in a fluid and volatile state, having an oily appearance.

The empyreumatic oil of tobacco appears to be formed during the destructive combustion, and does not exist naturally in the leaf, but is probably formed at the expense of the nicotina. It does not therefore exist in the infusion of tobacco, the mode of action of which differs in several respects from the other forms in which it is employed. The products of tobacco when burnt, as in smoking, are:—carbonate of ammonia, nicotianin, empyreumatic oil, soot, and some gases.

Nicotina seems to be the formidable principle of tobacco when used in the solid form, or as an infusion; and the empyreumatic oil, when it is smoked, or when obtained by destructive distillation. The action of nicotina is highly poisonous; a quarter of a drop will kill a rabbit; one drop can destroy a dog. It is distinguished from the other alkaloids obtained from the tribe of the *Solanaceæ* by *not* causing dilatation of the pupil; the external application of it to the eye produces other very alarming narcotic symptoms. The tenth part of a grain put into the eye of a cat causes strong convulsions, with foaming at the mouth, quick respiration, accompanied with rattling in the throat and rapid palpitations of the heart, which can be heard at a considerable distance, staggering, and paralysis of the hinder extremities, which symptoms disappear in an hour.

The empyreumatic oil, in the quantity even of a single drop placed on the tongue, excites convulsions and coma, without affecting the heart. It may prove fatal in two minutes.

Tobacco, therefore, is a very powerful agent, the active principles of which are extracted by water, either in the form of infusion or decoction. The local effects of tobacco-leaves, or any preparation of them, are those of an acrid substance; hence when taken internally they cause vomiting and purging, pain of the stomach and intestines, followed by inflammation and ulceration. The external application occasions irritation of the part, and if kept long in contact with it, inflammation: snuffing the prepared powder induces sneezing and increased secretion of mucus; chewing or smoking it causes increased secretion of saliva, with diminished appetite in those unaccustomed to its use.

Besides these local effects it has a secondary action, which results from the absorption of the active principles. It is immaterial by what channel they are introduced into the circulation: the same consequences follow, and affect on the one hand the intestinal canal, the lungs, and the heart; and on the other, the nervous centres of the brain and spinal chord. The former show themselves by nausea, vomiting, purging, pain and inflammation of the stomach, and here and there of the intestines; on the lungs, by the slower, painful, and irregular respiration; and after death the tissue of the lungs is found to be thicker, more injected with blood, and accumulations or extravasation of it. The action on the heart, or probably the nerves of the heart, manifests itself by irregular, generally slower pulsations, and by the heart losing its irritability sooner than after natural death; but the chief secondary action is on the brain and spinal chord, and this succeeds the external as well as internal application of it, but most so after injection into the rectum. Giddiness, weight, and pain of the head; deafness, a feeling like intoxication, staggering, trembling, general weariness of the muscles, with convulsive contractions of them, or cramps, general insensibility, sleepiness, and death are the consequences.

Tobacco must therefore be considered as a narcotic acrid poison. Habit reconciles the system to its action when used moderately, but nothing can secure the body from its irritative property and its ultimate absorption when employed in excess or incautiously. Uncontrollable fits of sneezing have produced death, and smoking a number of pipes or cigars has also caused death. The use of an infusion as a wash to the head in ringworm, or against the itch, has produced death by absorption through the abraded surface. The greater number of fatal cases have resulted from the employment of it as an injection into the rectum, either against worms, or, by a most singular practice, in the form of smoke in the case of persons drowned, a custom which ought to be strongly censured and relinquished.

The few cases which can justify the use of so formidable an agent are those in which great relaxation of the muscles is wished, such as to reduce dislocations or hernias, or to remove obstructions in the intestines, in ileus, and similar diseases. But the utmost caution is here requisite; and an injection of uniform strength, as ordered in the 'Pharmacopœia,' is to be prepared, and thrown up in divided portions, under the direction and in the presence of the medical attendant. In case of over-dose, vital stimulants, such as brandy or ammonia, must be resorted to. Tobacco is now nearly entirely superseded by chloroform in such cases. The infusion of tobacco has been recommended as a diuretic in some cases of dropsy; but it is a dangerous remedy, and seldom employed.

Against the common use of tobacco for snuffing or smoking it is perhaps useless to declaim. Chewing it is limited in a great measure to sailors, and it were to be wished that the practice of smoking were similarly restricted. The evils which follow indulgence in these customs are not very obvious, but that injury results in most cases is certain. [ANTIDOTES; ERRHINES.] Tobacco is largely sophisticated. These are frauds on the revenue, or on the purchaser, but not many of them are dangerous. Snuff, however, is adulterated at times with lead. The use of such adulterated snuff produces paralysis of some of the facial nerves.

NICOTIANIN, or *essential oil of tobacco* ($C_{46}H_{3}N_{2}O_{6}$).—A crystalline substance that slowly separates from the liquid obtained on distilling tobacco leaves with water. It somewhat resembles camphor, is volatile, insoluble in alcohol or ether, has a feeble odour resembling tobacco smoke, an aromatic bitter taste, and according to M. Barral, should give nicotine by distillation with potash. It seems to exist in tobacco in but very small quantity.

NICOTIC ACID ($C_6H_2O_6$, 2HO). A peculiar acid allied with oxalic acid, and said to be contained in tobacco juice. It crystallises in micaceous scales, but its existence as a distinct acid cannot be considered as established.

NICOTINE, *Nicotia* ($C_{10}H_7N$).—This alkaloid is the active principle of TOBACCO. [NICOTIANA *tabacum*, in NAT. HIST. DIV.] It was first discovered by Vauquelin in 1809, and probably exists naturally in the state of malate or citrate. It may be isolated by several methods; the following being the one proposed by M. Debize. A mixture of lime and tobacco is placed in a cylinder and a current of heated steam passed through it. The opposite end of the cylinder to that at which the steam enters is connected with a worm, by which the steam, nicotine, ammonia, and some undefined bases are condensed. In order to separate the nicotine, the condensed liquid is neutralised with sulphuric acid, concentrated by evaporation, and then treated with ether and ammonia. In this way an ethereal solution of nicotine is obtained, from which the alkaloid can be easily separated and purified by rectification.

The proportion of nicotine in the different kinds of tobacco varies considerably. According to M. Schlœsing, the centesimal amounts in some of the French and American tobaccos are as follows:—

Lot . . .	7·96	Alsace . . .	3·21
Lot-et-Garonne . .	7·34	Virginia . . .	6·87
Nord . . .	6·58	Kentucky . .	6·09
Ille-et-Vilaine . .	6·29	Maryland . . .	2·29
Pas-de-Calais .	4·94	Havannah, less than	2·0

In the manufacture of snuff, much of the nicotine is decomposed; seldom more than two per cent. remaining unaltered.

When tobacco leaves are burned the nicotine—or at all events the greater part of it—passes off along with the smoke, and in the impure state may be frequently seen condensed in oily drops in the stems of tobacco-pipes.

When pure, nicotine is a colourless oily liquid, of sp. gr. 1·027. It has a pungent, irritating smell, and persistent burning taste. It is exceedingly poisonous, one drop being sufficient to kill a large dog. Its chemical characteristics are such, that it can readily be detected in the stomach and blood of any animal that has swallowed a sufficient quantity to produce death. Exposed to the air, nicotine absorbs oxygen, becomes brown, and is ultimately converted into a solid resinous substance. Its boiling point is 480° Fahr., nevertheless it is so volatile at ordinary temperatures, that if one drop is spilt in a moderate-sized room, the atmosphere is rendered so irritating as to be scarcely respirable. It is also readily distilled with the vapour of water, or in a current of hydrogen. Ignited in the air it burns with a bright smoky flame. It is very soluble in water, alcohol, ether, and the fixed oils, only slightly so in turpentine, and is very hygrometric. On agitating its aqueous solution with ether, the latter extracts the whole of the nicotine, and forms, on standing, a layer on the surface of the water. Solutions of nicotine exert lævo-rotation on a ray of polarised light: their chemical properties are very similar to those of ammonia, but may be distinguished by giving a reddish-yellow precipitate with chloride of gold, very soluble in excess of nicotine; a blue precipitate, changing to green, with chloride of cobalt; yellow precipitate with aqueous solution of iodine; and an abundant white precipitate with pure tannic acid. The odour of nicotine, though tested for in the same way as for ammonia, is very different from the latter body.

Nicotine, like ammonia, is a powerful base combining with acids to form salts. It also yields iodine and methylic, ethylic, &c., derivatives. From the experiments of Kekulé and Von Planta and others, it appears that nicotine belongs to the class of nitrile bases, and is, in fact, ammonia in which the three equivalents of hydrogen are replaced by the teratomic radical *nicotyl* ($C_{10}H_7'''$).

Hydrochlorate of nicotine ($C_{10}H_7N$, HCl).—This salt is very deliquescent, but may be obtained in long fibres by the action of dry hydrochloric acid gas upon nicotine. *Sulphate of nicotine* is uncrystallisable. *Phosphate of nicotine* crystallises in large plates resembling cholesterin. *Oxalate of nicotine* is exceedingly soluble in water, but may be obtained in crystals; it is also soluble in boiling alcohol, but insoluble in ether.

Chloroplatinate of nicotine ($C_{10}H_7N$, HCl, $PtCl_2$) is a yellow crystalline precipitate produced on adding bichloride of platinum to an aqueous solution of nicotine neutralised with hydrochloric acid. It is very soluble in excess of nicotine; dilute hydrochloric acid also dissolves it when gently warmed, and redeposits it in oblique rhomboidal prisms. Several *chloromercurates of nicotin* exist.

Iodonicotine ($2C_{10}H_7N$, I_3) is formed on mixing together ethereal solutions of nicotine and iodine; from a dilute solution it slowly deposits in beautiful ruby-red needles. Potash decomposes it with liberation of nicotine. Hydrochloric acid combines with it to form rich ruby-red plates, containing ($2C_{10}H_7NI_3$, 3HCl).

Methylic, ethylic, and amylic derivatives of nicotine.—These bodies correspond to ammonium (NH_4) in which which three atoms of hydrogen are replaced by nicotyl, and the remaining one by methyl or its homologues. Their *iodides* are produced by the direct action of the iodide of the radical upon nicotine, the *hydrated oxides* being formed when the iodides are treated with recently precipitated oxide of silver. The hydrated oxides are powerful caustic bases resembling potash and soda; they perfectly neutralise acids, forming salts that are mostly crystalline precipitate the oxides of copper and of iron from their salts; and dissolve recently precipitated alumina with facility. The names and formulæ of some of them are as follows:—

Hydrated oxide of methyl-nicotium $\left.\begin{array}{r}NC_{10}H_7'''C_2H_3\\ H\end{array}\right\}O_2$

Iodide of ethyl-nicotium . . $\left.\begin{array}{r}NC_{10}H_7'''C_4H_5\\ I\end{array}\right\}$

Chloroplatinate of amyl-nicotium . $\left.\begin{array}{r}NC_{10}H_7'''C_{10}H_{11}\\ Cl\end{array}\right\}PtCl_2$

NICOTYL. [Nicotine.]

NIELLO is a method of ornamenting metal plates, practised chiefly during the middle ages. Upon the plate—which was most commonly of silver, but sometimes of gold or copper—the design was first sketched with a style, and then somewhat deeply engraved with a burin or graver. [Engraving.] The lines thus incised were filled with a composition called from its colour *nigellum* (whence the Italian *Niello*), and, the plate being polished, an effect was produced something like that of a pen-and-ink drawing. The composition was an amalgam of quicksilver, silver, and lead, (with occasionally a little copper) melted together, and blackened by the addition of sulphur. When cold the nigellum was pounded and kept ready for use. This powder was laid, with borax, on the incised lines, into which it was melted by a gentle heat being applied to the back of the plate, which when cold was polished and burnished, and the work was complete.

This kind of engraving is of considerable antiquity. It appears to have been practised in the early centuries of Christianity by the goldsmiths who prepared the more costly articles for ecclesiastical purposes. Two small gold cups which had in the centre crosses in niello were bequeathed by the Abbot Léodebode to the convent of St. Aignan d'Orleans in the 7th century. At the beginning of the 9th century a pectoral cross, of which one side was decorated in niello, was sent by Nichephorus, patriarch of Constantinople, to Pope Leo III.; and towards the end of the same century, various articles of silver engraved in niello were made at Constantinople for the church of St. Mark at Venice. The art in these early times seems to have been chiefly practised by Byzantine artists; but in the 10th century we find it practised both in Italy and Germany, though the workmen may possibly have been Greeks. From the 12th century niello seems to have formed a regular part of the goldsmith's art, and it was applied to the ornamentation of a great variety of articles, as well for secular as for ecclesiastical purposes. The Italian goldsmiths especially acquired great skill in the art, and produced works of exceeding beauty of design and execution.

As mentioned under Engraving, niello is regarded as the parent of engraving in the modern sense of the term, that is, for taking impressions on paper. The application is usually ascribed to Maso Finneguerra, the most famous of the Florentine workers in niello. In order to observe the progress of their work the niellatori were accustomed to take casts from it at various stages in clay, upon which they poured melted sulphur, and thus obtained fac-similes of their engraving. Into these lines in the sulphurs, as they are called, they rubbed a composition of oil and lamp black, and were thus able to judge of the appearance of the plate after the insertion of the nigellum. According to Vasari, and other Italian authorities, it occurred to Finneguerra that he might save himself much of this troublesome process by filling the lines in the original plate with a similar composition, and taking impressions directly from it upon damped paper. Not only was his experiment successful, but these impressions on paper soon grew to be so much in request that niellatori found it a profitable occupation to prepare plates especially for their production; and their extension to the imitation of paintings and drawings soon followed, and engraving became a distinct profession. At the same time, however, the working in niello proper seems to have declined; since Benvenuto Cellini relates that by 1515 the method of executing niello was nearly forgotten in Florence, when he, stimulated by the admiration expressed for the nielli of Finneguerra, applied himself with great diligence and entire success to the restoration of the lost art. Of this period many beautiful works, including suits of armour and other large articles, adorned with nielli are still extant, as well as numerous smaller articles. The art, however, gradually passed out of use, and old nielli are now comparatively rare, and placed among the most precious articles of public and private collections. Among the public museums, the British Museum is one of the richest in nielli, and in impressions in sulphur and on paper—having about 70 silver plates, including some of extreme rarity and beauty of style, several fine sulphurs, and above a hundred proofs on paper, some of which are unique. Reference has been made to these last in the article Engraving: it will be enough therefore to add that a case has recently been placed in the King's Library, open consequently to public inspection, which contains some of the finest of nielli, sulphurs, and proofs, so arranged as to illustrate the history of the art, and its connection with that of engraving. The national museums at Paris, Vienna, Berlin, and Dresden, are also rich in nielli.

(Duchesne, *Essai sur les Nielles;* Bartsch, *Le Peintre Graveur*, vol. xiii; Passavant, *Le Peintre Graveur*, vol. i.; Ottley, *History of Engraving.*)

NIGELLIN, a non-azotised extractive matter, of unknown composition, obtained from the seeds of the cultivated nigella.

NIHIL ALBUM, an old alchemical name applied to the exceedingly light oxide of zinc obtained by burning the metal in air. [Zinc, Oxide of.]

NIMBUS. The terms Nimbus, Aureole, and Glory are often used indifferently for the marks of divinity or sanctity which encompass the person or encircle the head of figures in early art; but they have a well-marked distinction, the observance of which is important in Christian iconography. The term *Nimbus* is strictly confined to the disk or halo which surrounds the head; *Aureole* to that which envelopes the entire person; while *Glory* is by the best authorities applied to the union of both

The nimbus, or a corresponding attribute, is of great antiquity. It is found alike in the art of India, Egypt, and Greece. Its origin is supposed to be the East. Ciampini and Wilkinson point to the disk on the head of the Egyptian god Re, or the sun, as the original of the nimbus. A nimbus or aureole is seen surrounding the Hindoo goddess Maya. From the Egyptians the nimbus was borrowed by the Greeks for their sun-god Apollo. It occurs also on Etruscan vases; and in paintings found at Herculaneum and Pompeii, Roman divinities and heroes are seen with nimbi almost identical with those of the sacred personages in mediæval art.

It is frequently said that the nimbus was derived from a custom which prevailed in classic times of placing a disk of metal over the head of statues of the gods to save them from defilement by birds, &c.; but, as we have seen, both the nimbus and aureole were of a date long anterior to the classic period, and it is only in late examples that the nimbus is placed above the head like a protecting disk. There can be little doubt that, as M. Didron suggests, the original idea of the nimbus and aureole was that of an emanation of light or flame, its signification that of power. The same idea seems to have been common to all the Arian races, and was probably derived from the primitive worship of the sun. Thus, as we have seen, in its oldest known form it was the attribute of the Egyptian sun-god Re, as it was afterwards of the Greek Apollo. The same conception is indeed sanctioned in the sacred Scriptures, where we in various great manifestations find the presence of the divine power expressed by an emanation of light. David, for example (Ps. civ. 1–4), speaks of the Lord as "clothing himself with light as with a garment," the idea evidently intended to be conveyed by the aureole; the face of Moses, when he came down from Mount Sinai (Ex. xxxiv. 29–35), shone with unbearable light—an idea sought to be conveyed by the nimbus; while in the New Testament (Luke ix. 31, 32) we are told that our Saviour at his Transfiguration appeared "in his glory, his raiment white and glistering," to the disciples who accompanied him on the mountain.

Passages like these, as they are quoted to sanction the application of one or other forms of the glory to the holy personages of the Christian Church, might almost seem to have suggested their use, had we not evidence that they were generally employed in pagan times, and that they were in fact mere appropriations by Christian artists from pagan art. Neither the nimbus nor the aureole is seen in the earlier Christian iconography. The nimbus first appears in miniatures of the latter part of the 5th century; the aureole not till some time later. Both continued in use in miniatures, mosaics, sculpture, and painted windows throughout the middle ages, only giving way before the revival of classic art in the 15th century, and disappearing in the 16th; the aureole, as it had been latest introduced, being the first to be abandoned.

By the mediæval ecclesiastics and artists, a great extension was given to the use of the nimbus, and much importance attached to it. No longer was it merely the emblem of deity, but the general attribute of ecclesiastical apotheosis. The broad distinction was however maintained that, whilst the nimbus was common to all who were thus distinguished, the aureole was confined to the three persons of the Trinity and the Virgin Mary: the varying forms and symbolism of these attributes are among the most important points in the study of Christian iconography.

The nimbus is most commonly circular; but it occurs in a great variety of forms, depending partly on the time or country, partly on the symbolic idea, often no doubt only on the individual taste or fancy of the artist: sometimes (in the Father and the Son) triangular, or as a double triangle; hexagonal; lozenge-shaped; as a roll partially unfolded; like a triptych; and even square, but this only in the case of bishops and other churchmen represented whilst yet alive. Sometimes the nimbus of the three persons of the Trinity consists of an emanation of light without a circumscribing outline, the rays forming the three arms of a cross; but usually the outline is added. These cruciform rays are confined to Deity. Sometimes the nimbus is opaque, with a broad ornamented border (that of the Virgin, for instance, is often very richly adorned), or the border contains the name of the person represented; sometimes, and especially when art was passing out of the region of symbolism, it was transparent; and before its entire disappearance, as in some of the pictures of Raffaelle and his contemporaries, there is only the faintest indication of a nimbus, and that, instead of encircling the head, is placed above it. The nimbus is usually of gold,—that of the divine personages and of the Virgin almost invariably so,—but sometimes it is otherwise coloured (blue, red, purple, white) in the case of apostles, saints, and other holy persons. The colour is regarded in many of these instances as symbolical: Didron mentions a Judas with a black nimbus. The persons who in mediæval art are represented with the nimbus are, as has been seen, the three persons of the Trinity, the Virgin, angels, the patriarchs, prophets, apostles, &c., of the Old and New Testaments, and all who had been canonised by the Church. But princes, popes, and bishops, living as well as dead, likewise frequently bear this attribute of apotheosis, though they could have no such claim to it. It is often figured also on symbolical animals, as the lamb, the beast with seven heads of the Apocalypse, &c.; and a hand encircled with a nimbus which has the cruciform rays is a well-known symbol of the Father; but the hand when stretched forth from a cloud has frequently, instead of a nimbus, a stream of light issuing from it. The Hebrew word Jehovah is often painted on a triangular nimbus.

The aureole, as has been said, instead of encircling the head only, like the nimbus, encompasses the entire person. It is confined, with rare exceptions, to the Trinity and the Virgin Mary: the exceptions are mostly of late date, and comprise such representations as the souls of certain saints, or the Magdalene in an ecstacy. The usual form of the aureole is a pointed oval, formed by the intersection of circles of equal diameters. This is commonly termed a *Vesica piscis*, from a fancied resemblance to the form of a fish, which in its turn was supposed to be symbolical of the Saviour, from its name in Greek (Ἰχθυς) containing the initial letters of the names and titles of Jesus Christ. But this is probably a strained fancy. There can be little doubt that the oval form of the aureole was given to it from the outline circumscribing the rays of light emanating from the divine person most readily assuming that regular form, as the outline circumscribing the rays emanating from the head would naturally take the circular shape of the nimbus. Sometimes the aureole is contracted at the neck and ancles of a standing figure. Around a seated figure it becomes circular in form, or occasionally takes the shape of a quatrefoil. In Byzantine art it is seen circular, with rays or lines diverging from the centre, so as to resemble a wheel. Some miniatures show the aureole like an encircling cloud. French artists frequently gave the outline a wavy appearance; and other divergences from the regular form might be mentioned. The aureole is, like the nimbus, commonly gold; but it is frequently coloured. Sometimes, for instance, when the Father is represented within the aureole, his feet resting on a rainbow, the ground of the aureole is azure, and powdered with golden stars. At first the aureole, like the nimbus, had an enriched border; but in the 15th century the border was first diminished, and then omitted, the aureole itself soon after ceasing to be represented.

With the recent revival of mediævalism, both the nimbus and aureole have reappeared in ecclesiastical art. Even in Protestant churches they are now almost universally figured, and the nimbus is not confined to the saints of the Scriptures: thus "King Charles the Martyr" is represented with the nimbus in a stained glass window erected a few years ago in Kilndown Church, Kent.

(The fullest information respecting the nimbus and aureole will be found in Didron's *Iconographie Chrétienne*; but Mrs. Jamieson's *Sacred and Legendary Art*, and works of a similar class, should also be consulted; while D'Agincourt's *Histoire de l'Art par les Monumens*, will, with the works just named, supply an ample number of examples.)

NINEVEH, ARCHITECTURE OF. Until the year 1843, the very sites of the great cities of the mighty Assyrian empire were little more than matter of conjecture. Rude mounds of earth, and huge heaps of unburnt brickwork, served to stimulate the wonder of travellers and the curiosity of archæologists; but the most searching investigations of travellers like Rich and Niebuhr did not suffice to remove the obscurity which involved the question of where stood Nineveh and Babylon, and what was the character of their buildings? The wondrous extent of the cities, and the magnificence of their architecture, were attested alike by the Old Testament scriptures, and by Greek historians and geographers [NINEVEH, in GEOG. DIV.], but neither the one nor the other supplied the means of reproducing with the faintest approach to certainty, any of these vast edifices. The explorations of Messrs. Botta and Layard, in 1843 and following years, and of those who succeeded them in their labours, however, brought to light sufficient to prove the accuracy of the contemporary accounts of the splendour of the Assyrian palaces, and to enable the accomplished architect to reproduce with tolerable distinctness the buildings themselves.

The excavations which yielded such marvellous and unexpected results, were carried on chiefly at Nimroud, Khorsabad, and Kouyunjik, situated on the east bank of the Tigris nearly opposite Mosul, and within a district about 30 miles in length; and, as Mr. Layard, the great authority on the subject, believes, all forming at one time portions of the same great city: "the numerous royal residences, surrounded by gardens and parks, and enclosed by fortified walls, each being a distinct quarter known by a different name, formed together the great city of Nineveh," though by others they are rather regarded as separate cities. In all ten great buildings have been discovered, and all of them have precisely the same character, being palaces, or rather palaces and temples combined, the king having a sacred character, and being chief priest as well as governor. Nineveh was founded some 2000 years B.C.; but the oldest building yet discovered appears, from inscriptions on it, to have been built in the reign of Sardanapalus, B.C. 930, the latest was hardly finished at the destruction of the city, B.C. 625; the architectural examples therefore extend over a period of 300 years, but leave the archaic period unillustrated.

The palace-temples of Nineveh yet discovered were all built on an artificial mound or platform raised 30 or 40 feet above the level of the ground. These mounds or terraces were of vast extent; that of the palace of Sennacherib at Kouyunjik was a mile and a half in circumference. They were partly of earth and rubbish, and partly, or, as at Khorsabad, wholly of regular layers of sun-dried bricks cemented together with clay, faced with slabs of stone, and supported by solid masonry. The object in raising these costly substructures was probably, as Mr. Layard suggests, to secure a certain amount of coolness during the summer heats, as well as to impart dignity to the building, and afford a means of defence. The process of raising these mounds, and of erecting the buildings, is minutely depicted in the marble slabs brought from the buildings themselves, and now deposited in the British Museum and the Louvre.

The buildings appear to have consisted of a series of chambers invariably rectangular, and usually oblong, placed side by side, and with studious symmetry around great halls or square open courts. These chambers occur from one to two hundred feet in length, and from twenty to forty in breadth. From this great central block suites of smaller rooms project as wings, the rooms decreasing in size and richness as they recede from the centre. In some of the palaces long galleries connect the several parts. The great halls and courts, with some of the chief apartments, appear to have been devoted to purposes of state and ceremony; while other portions were, as Mr. Fergusson has shown, set apart in accordance with eastern habits for the use of the females, or, as it would now be termed, the harem.

Both externally and in the interior, the palaces were of extraordinary magnificence. The approach to the building was at Khorsabad, and perhaps elsewhere, if Mr. Fergusson's restorations be correct, by way of an outer and lower mound, "on which were situated the great portals of the palace, and the residence of the guards and inferior officers; and beyond even this, on the plain of the city, a set of interportals are found, from which the great winged bulls, now in the British Museum, were taken." Passing these portals a flight of steps led up to the palace. The building itself was nearly square, with two principal façades, one of which, where the palace was built by the Tigris, usually overlooked the river; the other was on the opposite side. Each front had three entrances, the principal being in the centre. The sides, or jambs of the central portals, were formed by slabs, on which were sculptured colossal human-headed and winged bulls, 16 or 18 feet high; the side doorways being usually guarded by colossal figures of divinities or kings, but in some instances by winged-bulls similar to those of the chief entrance. Between the doorways, pairs of these winged-bulls, of somewhat smaller size, were placed back to back, with sometimes colossal human or symbolical figures between them. The rest of the walls, to the height of about 9 feet, were faced with slabs, on which were carved single figures or groups, of the kind familiar to every one, by the examples in the British Museum or the popular works of Layard, Bonomi, and others. The walls themselves, which were of immense thickness were built of sun-dried bricks; the sculptured slabs are chiefly of calcareous stone or alabaster. Of the actual buildings, only these lower sculptured walls, with a few feet of the brick surface above, remain.

The character of the upper part of the building is conjectural. But following out the indications on the extant parts, it seems pretty evident that the brick walls were carried up at least to the height of the great bulls, or about 18 feet, the surface being covered with stucco, and painted with various figures of the king and his attendants, mythological subjects, &c., or in conventional patterns. From large quantities of charred wood being found within the chambers, and no remains of a stone or brick superstructure, it is conjectured that the superstructure, of whatever description it was, was constructed chiefly or wholly of wood. This superstructure, Mr. Fergusson, who has more thoroughly studied the subject than any other authority, considers to have consisted of "a gallery or upper story to the palace; and thus in the heat of the day, the thickness of the walls kept the inner apartments free from glare, while in the evenings and mornings, the galleries formed airy and light apartments, affording a view over the country, and open on every side to the breezes that blow so refreshingly over the plains. It will thus," he adds, "be evident that the direct rays of the sun could never penetrate into the halls themselves, and that rain, or even damp, could easily be excluded by means of curtains or screens."

The roof Mr. Fergusson supposes to have been supported on low wooden columns, resembling in style those of stone still standing at Persepolis, and others recently found at Susa; grounding his opinion on the fact made evident by the discoveries at Nineveh, that the Persians in their architecture imitated that of the Assyrians; reproducing as well as they could, the winged-bulls and other characteristic sculpture, as well as the general form of the buildings, and, as is highly probable, copying in stone the wooden columns of their prototypes. No complete column, it must be understood however, has been exhumed among the Assyrian remains, but only fragments of bases, and none of these are of wood. In the relievi which cover the walls of the Assyrian palaces, columns of various kinds occur, including, as it would seem, the original of the Greek Ionic; the open gallery, or upper story is also distinctly indicated. From these, and from the Persepolitan columns, Mr. Fergusson conjectures that the wooden columns of the palaces of Nineveh, were short and thick, with carved shafts, and large capitals. A favourite form of the capital appears from the Assyrian relievi and the existing Persepolitan examples to have consisted of two bulls set back to back. The columns are often figured as resting on winged bulls and lions placed back to back. The gallery was crowned by a curved cornice, which appears to have been richly adorned with conventional decorations, which are certainly the originals of the well-known Greek guilloche and honeysuckle ornaments. Surmounting the cornice was a stepped battlemented parapet of a pattern peculiar to Assyrian architecture.

The roof was of wood and flat, its framework being formed by massive beams which were borne by the columns. Several of these great beams of cedar and other woods have been found at Nineveh, some nearly perfect, but others reduced to charcoal, and crumbling to powder when exposed to the air. The exterior of the roof was probably composed, as is still usual, of five or six feet of earth,—a plan adapted to keep out alike heat and wet.

Internally the great halls, courts, passages, and principal apartments, were, like the exterior, faced with slabs of alabaster, on which were carved the battles and sieges of the great king, the capture of cities and the presentation of captives and hostages; hunting scenes; various divinities, the sacred tree, and other mythological and symbolical subjects, &c. In some of the secondary buildings, or less important chambers, the walls were covered with stucco, and painted either with figures similar to those of the relievi or with conventional ornament. The pavement was formed of elaborately ornamented alabaster slabs or square tiles or bricks; both slabs and bricks bearing on their backs the name of the sovereign who erected the building. The ceilings were, as we know from the Scriptures, and as is proved by the remains, "ceiled with cedar and painted with vermilion," and probably adorned with gilding and inlaid with ivory. Traces of polychrome decoration are found everywhere. Both the exterior and interior walls, there can be little doubt, were painted with the most brilliant colours. Gold was profusely employed, and the images on the walls were "pourtrayed with vermilion, girded with girdles upon their loins, exceeding in dyed attire upon their heads, all of them princes to look to, after the manner of the Babylonians." (Ezek. xxiii. 14, 15.)

The buildings hitherto explored were, as has been said, palace-temples; but they also, as Mr. Layard observes, "appear to have been at the same time public monuments, in which were preserved the records or archives of the nation, carved on stone. In them were represented in sculpture the exploits of the kings, and the forms of the divinities; whilst the history of the people, and invocations to their gods, were inscribed in written characters on the walls." These inscriptions, in cuneiform characters, are carried over the surface of the larger relievi, without any regard to the effect of the sculptured design; and since the learned have succeeded in deciphering the characters they have furnished valuable information respecting the history of the people, as well as the construction of these monuments. [CUNEIFORM.]

Buildings such as those we have been describing, however splendid and imposing in appearance, were ill-calculated to withstand violence and subsequent neglect. Whilst the still older temples of Egypt are, in their great features, as strong and impressive as ever, the preservation of any portion of those of Nineveh is due to their being buried beneath the soil. But the very constructive defect which hindered their permanent maintenance may have contributed to the preservation of so much of them as remains. The columns and superstructure being of cedar would be an easy prey to the flames, but then the thick roof of earth "would alone suffice to bury the building up to the height of the sculptures. The gradual crumbling of the thick walls consequent on their unprotected exposure to the atmosphere, would add three or four feet to this; so that it is hardly too much to suppose that green grass might have been growing over the buried palaces of Nineveh before two or three years had elapsed from the time of their destruction and desertion. When once this had taken place, the mounds were far too tempting positions not to be speedily occupied by the villages of the natives; and a few centuries of mud-hut building would complete the process of entombment so completely as to protect the hidden remains perfectly for the many centuries during which they have lain buried, and to enable us now to restore their form almost as certainly as we can those of the temples of Greece or Rome, or any of the great nations of antiquity." (Fergusson, 'Handbook of Arch.,' i. 178.)

In the work named below, Mr. Fergusson has, with scrupulous care and rare ingenuity, endeavoured to exhibit such a restoration. He has also, as our readers well know, given a more tangible shape to his speculations in the actual restorations, both in form and colour, of the Assyrian Court at the Crystal Palace, Sydenham. In the main, these restorations have met the sanction of Mr. Layard and other authorities who, like him, have made the antiquities of Assyria a special study. Without, therefore, pretending to say that all Mr. Fergusson's views are borne out by our present knowledge of Assyrian remains, and without wishing to be understood as adopting his polychrome theory, we point the reader to these actual restorations, with Mr. Layard's convenient little 'Guide' descriptive of them, as well as to Mr. Fergusson's larger treatise, as affording the readiest and surest means of acquiring a definite conception of the leading characteristics of Assyrian palatial architecture. It may, however, be convenient to add a chronological list of the palaces discovered at or about Nineveh, adopting Mr. Layard's names of the founders and date of foundation.

The oldest is the North-West Palace, Nimroud, built about 900 B.C., by a king who is believed to be identical with the Sardanapalus of the Greeks. This, though not one of the largest, is one of the most beautiful of the palace-temples. The great hall is 152 feet long by 32 wide; at the upper end is the place of the throne, at the lower a vestibule overlooking the river. The façade was about 330 feet in extent. Like the other larger temples, the entire wall-surface, both inside and out, was faced with sculptured slabs, the best of which are now in the British Museum.

The Centre Palace, Nimroud, was built by a son of Sardanapalus, whose name has been read Shalmann-bar, and who was contemporary with Jehu, king of Israel, who, according to the inscriptions on the palace, was tributary to the Assyrian king. Its date, therefore, is somewhere about 885 B.C. From finding slabs partly removed, and other appearances, Layard was led to conclude that this building had been despoiled to provide materials for building the South-West Palace, in which he found slabs identical in style and execution with those placed ready for removal in this.

At Kalah-Shergat, on the right bank of the Tigris, and perhaps the site of the Calah of the Scriptures, are the remains of a palace built by the founder of the Centre Palace. The mound is of unusual extent; but the palace contains, so far as is known, no sculptured slabs. A seated basaltic figure, now in the British Museum, was however found there.

The Upper Chambers, Nimroud, is a small palace, built about 800 B.C. by a successor of Shalmann-bar, named Shamasphal.

The Palace at Khorsabad was one of the most remarkable of these palace-temples. It stood on a square mound, the sides of which were 650 feet long, and the approach was by a lower mound at least 1300 feet long and 300 feet wide. The great rooms were 116 feet long by 33 wide. The design is uniform throughout, and the sculpture of the best class of Assyrian art. It is from this palace that the sculpture in the Louvre is chiefly derived. The palace appears to have been wholly built by Sargon, about 720 B.C. The arch, both as a constructive and decorative feature, is shown to have been well understood by the Assyrians at this time.

The great Palace at Kouyunjik was built by Sennacherib, son of Sargon, about 700 B.C. This was the largest and most magnificent of the palaces of Nineveh. It stood on an artificial mound 7800 feet in circumference; the palace proper, which contained three great inner courts and above 60 apartments, occupying a square, the sides of which were 600 feet long. In extent it was only surpassed among the buildings of antiquity by the great temple of Thebes, and the entire wall-space was covered with sculpture. The chief of the slabs are now in the British Museum.

The South-West Palace, Nimroud, was built by Esarhaddon, the son of Sennacherib, who seems to have despoiled the previously-existing palaces, and especially the North-West Palace, for its decoration. The only part which appears to have been saved from entire destruction is the great hall, which is 165 feet long by 62 feet wide—the largest hitherto met with.

Another palace, supposed to have been built by the same king, was discovered in the mound known as the Tomb of Jonah.

A second great palace, discovered near that of Sennacherib, at Kouyunjik, appears to have been built about 650 B.C., by a son of Esarhaddon, named Asshur-bani-pal. It is characterised by greater minuteness and finish in the sculptured slabs and architectural details, but in other respects resembles the other large palaces. The sculpture is in the British Museum.

The South East Palace, Nimroud, is small, and comparatively unadorned, and is only interesting as having been built by a grandson of Esarhaddon, and probably the last sovereign of the dynasty.

Besides these palace-temples no great buildings, properly so called, have, as we have said, been discovered. But in the great conical mound at Nimroud were found the remains of a huge square tower, constructed of sun-dried bricks, which up to the height of about 20 feet had been faced with well-laid solid masonry. It appears to have risen in three or four stages or stories to the height of perhaps 200 feet; at the present time about 120 feet are still standing. In the centre of the structure was found a gallery, about 100 feet long, 6 wide, and 12 high; it was quite empty, and afforded no clue to the original purpose of the building. Mr. Layard is inclined to believe it a place of royal sepulture, and that it was the tomb of Sardanapalus, so often referred to by ancient writers: Mr. Fergusson thinks that it was a temple. Another more strictly pyramidal seven-storied building was found by M. Place: it appears to have been a temple, resembling that at Babylon known as the Birs Nimroud. An object of great interest found in this mound was a large inscribed and sculptured monolithic obelisk of black marble, now in the British Museum. [OBELISK.]

The city wall, which, according to Diodorus Siculus (b. ii., c. 1) was 100 feet high, and so wide that three chariots might be driven abreast upon it, and which was defended by 1500 towers, each 200 feet high, has not been traced: nothing now remaining of it, says Mr. Layard, "but the long lines of mounds enclosing the ruins of Nimroud, Khorsabad, and Kouyunjik." But among the discoveries made by M. Place at Nineveh was that of one of the city gates. These appear to have been constructed in pairs of about equal width, from 12 to 15 feet; one gateway being devoted to wheeled carriages, the other to foot passengers, as is shown by the deep lines cut by the wheels in the pavement of the one, while that of the other is quite smooth. The foot passengers' gate is ornamented with slabs of human-headed winged bulls, alongside of which stand colossal figures strangling lions. The carriage gateway has plain slabs. Both have semicircular arches, with elegantly adorned archivolts formed of blue enamelled bricks with yellow figures.

The private residences, being constructed of sun-dried bricks, have entirely perished.

Babylonian Architecture.—Of the buildings of Babylon no complete example remains. Long before Layard or Botta began to excavate the buried Nineveh, Babylon had been the scene of frequent and careful, though by no means fruitful, explorations. The remarkable results of the researches at Nineveh led to a renewal of the investigation; but the success has been far from commensurable with the labour, and there is little reason to look forward to happier results at a future time. Like the ordinary dwellings of Nineveh, the buildings of Babylon were constructed entirely of brick, and where vast masses of brickwork remain they have utterly lost their form as buildings. The great mounds, which now comprise all that remains of the magnificent structures which excited the wonder alike of the ancient Hebrews and the polished Greeks, have been so fully described elsewhere [BABYLON, in GEOG. DIV.] that here a very brief notice will suffice.

The chief of the existing remains is that standing on the western side of the Euphrates, and known as the Birs Nimroud, a conical mound, formed of bricks, clay, and broken pottery, 762 yards in circumference, and at the western end rising to a height of 198 feet. On this summit is a solid structure of brick, 37 feet high and 28 feet broad, but diminishing to the top, which is broken and irregular. [See the cut and description in the article BABYLON, before referred to.] The building on the top is constructed of kiln-burnt bricks, and is in the best style of Babylonian brick-work; fragments of stone, marble, and basalt scattered about, show that it was adorned with more costly materials. The only openings are square holes pierced through the solid structure. By most writers it has been supposed to be the Temple of Belus, described by Herodotus; but there were always difficulties about the identification of the site, and the recent investigations of Sir H. Rawlinson have shown it to be a different building. Sir Henry, on discovering the angle of the basement wall by sinking a shaft, at once directed the workmen to look at a particular spot near it for a recess in which would be found a commemorative cylinder. This was done, and a cylinder covered with inscriptions [CUNEIFORM] was drawn out. A similar hollow with a duplicate cylinder in it was discovered near the opposite angle. On translating the inscription it was found to state that this building, the Temple of the Seven Spheres, which was built 504 years before (about 1100 B.C.), having become ruinous owing to the neglect of the drainage, the god Merodack had put it into the heart of the great King Nebuchadnezzar to rebuild it all but the platform which had not been injured. The building would appear from the investigations of Sir H. Rawlinson, to have consisted of a square basement about 360 feet on each side, and 6 feet high, on which stood a pyramidal structure of six stories, each about 20 feet high, and 42 feet less in horizontal extent than that on which it stands. These stories instead of being concentrically above each other, recede regularly, so that the front of the tower on the summit is above 200 feet from the front line of the basement, while the back is less than 100 feet from the rear line. The sides recede equally. The tower which crowns the summit, and which is spoken of above, was probably in two stories, and surmounted with a cornice. Within it was probably the shrine or holy place of the temple. In the front of the temple were steps leading from story to story from the basement to the tower at the summit. The seven stories, or platforms, were, Sir Henry believes, dedicated to the seven planets, and coloured with the colours attributed to them by the Sabæan astrologers. The lowest platform was panelled and painted black, the colour emblematic of Saturn; the second orange, the colour of Jupiter; the third red, Mars; the fourth gold, as dedicated to the Sun; the fifth green, for Venus; the sixth blue, Mercury; and the highest white, as the colour of the Moon, whose place was the highest in the Chaldæan system. This remarkable discovery accords not only very closely with the descriptions of Greek writers, but in general form with figures on slabs found at Kouyunjik, and is probably therefore nearly correct.

The mound called the Mujelibé, by Rich, or the Mount of Babel by Layard [described under BABYLON in GEOG. DIV.], seems to be the site of a great palace resembling, probably, in its general character the palaces of Nineveh; but it appears to be too utterly ruined to admit of any very definite restoration. The Kasr of Rich, Layard (who calls it the Mujelibé) conceives to have been a fortified palace. There are numerous other mounds, but they yield no insight into the peculiarities of Babylonian architecture; which, therefore, in the absence of any evidence to the contrary, we may fairly suppose to have been in its general characteristics, analogous to that of Nineveh. Its chief difference arose probably from being built wholly of brick. Instead of the walls of the façades and the interior being faced with sculptured slabs of alabaster, they were covered with fine moulded bricks or stucco, and painted with representations of a similar kind to those at Nineveh, but perhaps even more gorgeously coloured.

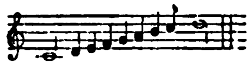
The architecture of Babylon was contemporaneous, or nearly so, with that of Persepolis and Passargadæ; and thus, as Mr. Fergusson suggests, her palaces may have "formed the link that would enable us to connect, in a satisfactory manner, the edifices and architecture of Assyria with those of Persia." It is noteworthy that none of the bricks found in or about Babylon are earlier than Nebuchadnezzar; in fact all, or nearly all, are inscribed with the name of that monarch.

Other mounds and heaps of brickwork are found at Mugheyr and Wurka in southern Babylonia; but they do not seem likely to throw much additional light on the architecture of the country. Two of the buildings at Wurka appear to have been palaces; but the most extensive of the mounds must, from the numbers of tombs and coffins found in it, have formed for centuries a vast cemetery.

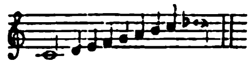
(Layard, *Nineveh and its Remains*, 8vo; *Monuments of Nineveh*, fol.; Fergusson, *Palaces of Nineveh and Persepolis Restored*; and *Handbook of Architecture*; Bonomi, *Nineveh and its Palaces*, 8vo; Botta and Flandin, *Monument de Ninive*, 5 vols., fol.)

NINTH, an interval in music, a discord retarding the 8th, but may be resolved into either the 6th or the 3rd; and though this is the octave of the 2nd, yet it is essentially different in harmony, both as to treatment and effect. [CHORD; THOROUGH-BASE.]

Of this interval there are two kinds; the major 9th, composed of six tones and two semitones—



and the minor 9th, composed of five tones and three semitones—



NI'OBE, the daughter of Tantalus, king of Lydia, was married to Amphion, by whom she had, according to Ovid and other ancient writers, seven sons and seven daughters. This is the most commonly received opinion, though Homer ('Il.,' xxiv. 602, &c.) and others give the numbers variously. The pride of Niobe at having this numerous progeny was so great that she is said in ancient story to have insulted Latona, the mother of Apollo and Diana, by refusing to offer at the altars raised in her honour, declaring that she had a better claim to worship and sacrifices than one who was the mother of only two children. Latona, indignant at this insolence and presumption, called upon her children to revenge her, and punish the arrogance of Niobe. Apollo and Diana heard the prayer, and obeyed the entreaty of their outraged parent. All the sons of Niobe fell under the arrows of Apollo, while the daughters in like manner met their death from the hands of Diana. Chloris alone escaped the common fate. She was the wife of Neleus, king of Pylos. This terrible judgment of the gods so affected the now heart-stricken and humiliated Niobe, that she was changed by her excessive grief into stone on Mount Sipylus in Lydia. Pausanias says (i. 21, 3) that the rock on Sipylus, which went by the name of Niobe, and which he had visited, "was merely a rock and a precipice when one came close up to it, and bore no resemblance at all to a woman; but at a distance you might imagine it to be a woman weeping with downcast countenance."

The fable of Niobe and her children has afforded a subject for art, which has been finely treated by one of the greatest ancient masters of sculpture. It consists of a series, rather than a group, of figures of both sexes, in all the disorder and agony of expected or present suffering; while one, the mother, the hapless Niobe, in the most affecting attitude of supplication, and with an expression of deep grief, her eyes turned upwards, implores the justly offended gods to moderate their anger and spare her offspring, one of whom, the youngest girl, she strains fondly to her bosom. It is difficult by description to do justice to the various excellence exhibited in this admirable work. Its great merit is independent of fine execution, in which it is inferior as a whole to many other well-known productions of the Greeks. Its excellence consists in the finer qualities of sentiment, as expression, grace, propriety, and variety of action, with that unity of effect by which the scene is brought dramatically and at the same time truly before the spectator, and a story of the most affecting interest told in language that cannot be mistaken. The arrangement of the composition is supposed to have been adapted to a tympanum or pediment. The figure of Niobe, of colossal dimensions compared with the other figures, which are life size, forms, with her youngest daughter pressed to her, the centre; while the rest of the sons and daughters are ranged in various ways on each side, some exhibiting expression of fear, others agonised with pain, others in grief, while one of the sons lies dead or dying, and stretched upon the ground. All are graceful, and some of the figures possess also great beauty, and the action and expression of many of the heads offer admirable examples for study to the artist. The whole attitude and expression of Niobe herself may truly be called sublime.

The colossal scale of the principal figure has justly been objected to as a fault. The artist doubtless had two purposes in view when he ventured on this deviation from truth. The first was the necessity which he felt of giving a superior height and volume to the apex and key, as it were, of his composition; and next perhaps the desire he had to concentrate the interest in his chief figure by forcing it thus upon the attention. But although we should hesitate before taking any exception to the practice of the great leaders and masters of art, yet, generally speaking, any departure from the truth of nature—the real canon of excellence when rightly studied—is so far from being commendable or admissible, that, where it has been indulged in by the ancients with the view of gaining greater effect and energy, it may usually be considered rather as evidence of their inability to work out their idea with the authorised means, than as a practice to be admired or imitated; and it may always be argued that they would have been so much the more entitled to our admiration if they had produced their works within those limitations which nature dictates. The productions which exhibit these faults, for they must be accounted so, will be found to be worthy of the high estimation in which they are held for other properties, and rather in *spite of* than *because of* the licence which their authors have allowed themselves.

The execution of this interesting monument of Greek art is attributed by some to Scopas, a native of Paros, who lived about 300 years before the Christian era; while others think it is the production of Praxiteles. Pliny says it was a question which of the two was the author of it. The group was in the temple of Apollo Sosianus at Rome. (Plin., 'Hist. Nat,' xxxvi.; Sillig., 'Catal. Artificum,' in verb.)

Flaminio Vacca says the group of Niobe and her children was found at Rome, but *outside* the walls, near S. Giovanni; but the learned antiquary Fea denies this, and says it was found near the Villa Altieri. The well known statues of the "Boxers" were discovered at the same place, and it has been supposed by some that they formed part of the group; the fable being that some of the children of Niobe were slain while thus exercising. (Winckelman, 'Sur l'Allegorie,' pref.)

All the above statues are in marble, and are now at Florence in the gallery of the grand-duke of Tuscany; but many of them are thought to be copies only, from originals now lost. There is in England a head of Niobe, which is engraved in the 'Select Specimens of Sculpture,' published by the Society of Dilletanti (vol. i., pl. 35) similar in action and expression, but preferable, for its style and execution, to that of the Florence statue; and as there are known repetitions of some of the other figures, it is not improbable that the principal and most interesting of the series may also have been frequently copied, and that the figure in the grand-ducal collection, though an ancient work, may come under this class.

The subject of Niobe and her children was a favourite one also with the poets of antiquity. Besides the beautiful story in Ovid ('Metam.,' vi. 146), there are numerous epigrams in the Greek Anthology, several of which have great merit, and appear to be descriptive either of the group of figures which still exists, or of some similar group. See particularly that beginning—

Τανταλὶ παῖ Νιόβα, κλῦ' ἐμὰν φάτιν ἄγγελον ἄτας.

(For further information and references as to the group of Niobe, see Thiersch, *Ueber die Epochen der Bildenden Kunst*, &c. pp. 368, &c.; and Mr. Cockerell's restoration of them as they probably appeared in the pediment of the temple of Apollo, in the *Galleria di Firenze*, ii., tav. 76.)

NIOBIUM (Nb), a metal lately discovered in the tantalate of Bavaria by H. Rose. When perchloride of niobium is submitted to the action of dry ammonia it becomes yellow, with considerable evolution of heat, and when this is heated it becomes black, with the disengagement of hydrochlorate of ammonia. On washing it with water, to free it entirely from this salt, the water passes clear as long as it contains any of it; but when the metal is nearly pure the water becomes turbid. When niobium is heated in the air it burns with the evolution of light, and becomes white niobic acid. Nitric acid and aqua regia, even when boiling, do not act upon niobium; but it is acted upon by a mixture of nitric and hydrofluoric acids, and a red vapour is formed during the action.

Niobic acid readily combines with the alkalies; and when fused with alkaline carbonates, carbonic acid is expelled. These compounds are soluble in water. Acids precipitate niobic acid from these salts.

Infusion of galls, added to a solution of niobate of soda, produces a deep orange-yellow precipitate. Ferrocyanide of potassium produces a similar effect, and the red ferrocyanide gives a deep yellow precipitate. When a plate of zinc is put into a solution of niobate of soda, a blue precipitate is formed, which in course of time becomes brown.

NISAN (נִיסָן) is the seventh month of the Jewish civil year. It was anciently the first month of the year, as appears from the Book of Esther, iii. 7. The name occurs twice in the Bible, once in Esther, as just mentioned, and again in Nehem. ii. 1. It is also found twice in the Apocrypha; in Esdras v. 6, and in Esther xi. 2: in the last case it is written Nison. In the inscription of Palmyra the month is written exactly as in the Hebrew Bible, and Josephus also writes Νισὰν. In the manuscripts containing the Calendar of Heliopolis, the name is read variously Νεισαν, Νυσσαν, or Νυασαν, and even Νιφα; but the manuscript containing the last two forms is said to be damaged. Renfey derives the name from Zend words signifying "new day;" but these words do not actually occur in Zend, as Renfey admits, though they are very probable forms. We would rather derive it from the Zend *nava sareda*, new year; a name almost certainly in use among the Persians, for we find the Armenians, who adopted the Persian calendar, using to this day the name of Navasardi for their first month; the Zend *rd*, as shown by Opperk, becomes *l* in Persian, and the word sarda has now become actually *sal*. [See also Elul.] The final *l* often becomes *n* in Semitic dialects, and the few Samaritans who are now remaining say Israen for Israel, and gaman for gimel. Nisan varies with the lunar calendar from March to April: in this year (1860) it begins on the 24th of March and ends on the 22nd of April. The feast of the Passover begins on the 15th day of the month. A fast is set down by some authorities for the 10th of the month, in memory of the death of Miriam, and another on the 26th for the death of Joshua; but they do not appear to be generally observed.

There are thirty days in Nisan, and the month must not begin on either Monday, Wednesday, or Friday.

NISI. [Rule in Law.]

NISI PRIUS. This phrase in English law is derived from an ancient writ in which the words occur. Previously to the time of Edward I., trials by assizes or juries could only take place in the *curia regis*, wherever the king happened to be resident, or before the justices in eyre on their septennial circuits through the several counties of England. But by the stat. 13 Edw. I., cap. 30 (forming a part of that series of laws commonly called the Statute of Westminster 2), the judges were directed to take certain assizes, and also to try certain inquests, by juries in every county not oftener than three times in every year; but the statute required that the day and place in the county in which an issue was to be tried by the judges should be mentioned in the judicial writ which assembled the jury. Accordingly the Venire facias, or writ for summoning the jury (commanding the sheriff to bring them to Westminster to try the particular cause in which issue had been joined), contained a proviso, thus:—"We command you that you cause to come before our justices at Westminster on the morrow of All Souls, twelve lawful men, who, &c., *unless before* (nisi prius) that day, A.B. and C.D., our justices assigned for that purpose, shall come to your county to take the assizes there." It was, in practice, always arranged that the day for the return of the jury at Westminster should be more distant than the day for taking the assizes in the county; and consequently the exception in the writ invariably took effect by the justices of assize coming into the county and trying the cause before the sheriff was called upon to obey it by returning the jury to Westminster. [Assize.] From this clause in the *Venire facias*, the phrase Nisi Prius came to be adopted as a general term descriptive of the large class of judicial business which is transacted before judges of the superior courts at the assizes. Thus the judges of assize are, when sitting alone to try causes, said to be sitting at Nisi Prius; and the law relating to the various matters which arise before them is, somewhat indefinitely, called the Law of Nisi Prius. It is erroneously stated in our text-books that the judges on circuit act under a commission of Nisi Prius. This is a common error, derived however from high authority, as it is so stated by Bacon in his 'Essay on the use of the Law.' There is in truth no such commission known to our law, the authority of the justices at Nisi Prius being incidentally annexed to the commissions of assize. In Middlesex the judges sit at Nisi Prius by statute 18 Eliz., c. 12; in London by vrtue of immemorial usage.

NITRATE. [Nitrous Acid.]

NITRATES. [Nitrogen.]

NITRIC ACID. [Nitrogen.]

NITRIC ACID, *Medical Properties of*. This acid in a concentrated form acts as a violent corrosive poison, and is therefore never used in an undiluted state for internal administration, but is sometimes applied externally, when the object is to effect the speedy destruction of any part. Nitric acid however, from its frequent employment in the arts, is often the cause of accidental, rarely of intentional, poisoning, and it surpasses all the other mineral acids in the rapidity of its action, and in the consequent necessity for prompt and judicious treatment. It may be determined to have been the poisoning agent by its causing the parts which it has touched to be at first white, but soon after of a yellowish colour, which cannot be removed, like the stain of iodine, by adding caustic potass, but on the contrary becomes orange on the addition of an alkali or soap. (Pereira.) When it has been taken internally, the lining membrane of the mouth also peels off in a state resembling parchment. The most appropriate antidotes are such substances as combine with and neutralise the acid: chalk or magnesia, made into paste with water—or, if these are not at hand, the plaster of the apartment, bruised down and drank—will answer best. "While these are preparing, the acid should be diluted by the free use of any mild fluid, milk or oleaginous matter being preferred. The carbonates of the alkalies are by no means eligible antidotes, as the resulting compounds themselves possess corrosive properties." (Christison.) A solution of soap may be administered, though some object to it from the presence of the alkali in it, but apparently without sufficient ground. If recovery should take place, the individual long suffers from indigestion, and is almost always constipated.

In an undiluted form, nitric acid is a most valuable application to sloughing phagedenic ulcers; also for destroying warts; for the destruction of hæmorrhoidal tumours (see observations on this subject by Henry Lee, London, 1848); or causing vesication over the stomach in Asiatic cholera, or for dropping into a carious tooth to relieve toothache. For all other purposes it is very largely diluted.

In its action on the system it differs from other acids, inasmuch as it does not produce the cooling and thirst-allaying effect which they do, but on the contrary causes a feeling of warmth in the stomach, with thirst and increase of appetite. The use of it continued for some time gives rise to general effects; an excitement is felt through the whole system; the pulse becomes quick, the exhalation great; and an increased secretion from the salivary glands, mucous membranes, the liver, and kidneys is manifest. Perseverance in the use of this agent however at last produces many bad consequences; and in persons much disposed to bleeding from the lungs, it almost invariably causes such bleeding to occur, as well as heat in the chest and obstinate cough. Very largely diluted, it furnishes one of the best drinks in fevers accompanied with great prostration of strength.

It is also a very excellent tonic in many cases, and seems to form the best substitute for the bile where that secretion is scanty. That it greatly augments the secretion of bile, the nature of the evacuations abundantly proves. Hence it differs from almost all other tonics in not causing constipation, but rather the contrary. In calculous diseases of the phosphatic diathesis it has been used with great benefit; and also, very largely diluted, it has been injected into the bladder as a direct solvent. [LITHONTHRIPTICS.] In the treatment of scrofula it is a most valuable remedy, but its use must be every now and then suspended, owing to the effects which it produces on the stomach. During its use, care must be taken to protect the teeth, by instantly rinsing the mouth.

It has been regarded as a substitute for mercury in some cases, especially as it promotes the secretion of saliva. It ought never to be given at the same time as mercury, nor even soon after a dose of any mercurial preparation, since a poisonous nitrate of mercury may be formed in the stomach. Lastly, nitric acid increases the efficacy of many other medicines, such as ammoniacum, cusparia, and opium.

Nitric acid in the form of vapour was formerly employed as a disinfecting agent, but it is now almost disused. The vapour must be carefully avoided, as the inhalation is very deleterious.

Nitric acid in combination with hydrochloric acid, added to a large quantity of water, has been used as a bath in chronic diseases of the liver, particularly in India, but it does not seem entitled to much credit.

Nitro-hydrochloric acid is a most valuable tonic in some forms of indigestion and debility, in combination with bitters.

NITRIC OXIDE. [NITROGEN.]

NITRIDES. [NITROGEN.]

NITRIFACTION. When organic matters containing nitrogen undergo decay in the presence of alkaline substances, such as lime or potash or their carbonates, a considerable quantity of the nitrogen becomes converted into a nitrate of the base at the expense of atmospheric oxygen. When potash is the base present, the matters generally become coated with an encrustation of crystalline nitrate of potash, commonly called nitre: hence the name of the process. Much of the nitre of commerce is thus made.

NITRILES, a generic name applied in chemistry to compounds which are obtained by removing four equivalents of water from the ammonia salts of certain acids; thus acetonitrile, or the nitrile of acetic acid, is produced as follows:—

$$\underbrace{\left.\begin{matrix}C_4H_3O_3\\NH_4\end{matrix}\right\}O_2}_{\text{Acetate of ammonia.}} \quad - \quad 4HO \quad = \quad \underbrace{C_4H_3N}_{\text{Acetonitryl.}}$$

The nitriles are now known to be identical with the cyanides of the positive radicals; thus acetonitrile is cyanide of methyl:—

$$C_4H_3N \quad = \quad \left.\begin{matrix}C_2H_3\\C_2N\end{matrix}\right\}$$

NITRITES. [NITROGEN.]

NITRO. NITR. Prefixes used in chemistry to denote the presence of nitrous acid (NO_4) as a substitute for hydrogen, in the body to which they are attached. Thus nitro-benzole ($C_{12}H_5(NO_4)$), nitraniline ($NC_{12}H_6(NO_4)$). Such compounds when not mentioned under their respective names, will generally be found described under the name of the body to which the prefix is added.

NITROBENZIDE. A nearly obsolete name synonymous with *nitrobenzole*. [BENZOLE, *nitrobenzole*.]

NITRO-BENZOIC ACID. [BENZOIC ACID.]

NITRO-CHLOROBENZOIC ACID. [BENZOIC ACID.]

NITROCOCCUSIC ACID. ($C_{16}H_5(NO_4)_3O_8+2\,Aq.$) Derived from carminic acid [CARMINE], by the action of strong nitric acid at a boiling temperature. Oxalic acid is formed at the same time, but may be separated by precipitation with nitrate of lead, nitrococcusic acid not being thrown down by that reagent. On evaporating the filtrate from the oxalate of lead precipitate, nitrococcusic acid crystallises out, and may be obtained perfectly pure by two or three recrystallisations.

Nitrococcusic acid occurs in yellow rhombic plates. It is soluble in water, alcohol, or ether, and deflagrates violently on being heated. Its solution stains the skin of a yellow colour; dissolves iron and zinc, becoming dark-coloured; and is decomposed by sulphide of ammonium with separation of sulphur and formation of a new acid not yet examined. The *nitrococcusates* have the general formula ($C_{16}H_3M_2(NO_4)_3O_8+x\,Aq.$); those of ammonia, potash, baryta, copper, and silver are crystalline and soluble in water.

NITRO-ERYTHROMANNITE. [ERYTHRIC ACID.]

NITROGEN. This gas constitutes seventy-nine hundredths, or about four-fifths, of the atmosphere. Its name is derived from the Greek words *νιτρον*, *nitre*, and *γεννάω*, *I produce*. It was formerly called *azote*, or *azotic gas*, from *a privative*, and *ζωή*, *life*, indicating its inability to support respiration. It was first discovered by Dr. Rutherford of Edinburgh; he gave it the name of *mephitic air*, and described it in his 'De Aëre Mephitico,' published in 1772. Dr. Priestley procured it about the same period, and described several of its qualities in the 'Philosophical Transactions' for 1772; he afterwards called it *phlogisticated air*.

This gas may be obtained by several processes. Dr. Rutherford separated it from the oxygen gas, with which it forms atmospheric air, by repeatedly breathing the same portion of atmospheric air, and agitating it afterwards with a solution of caustic alkali; this absorbed the carbonic acid formed during respiration, and left the nitrogen gas unacted upon.

Dr. Priestley procured nitrogen gas by exposing a given volume of atmospheric air to a mixture of sulphur and iron filings; by this the oxygen was absorbed, and the nitrogen gas left. He also prepared it by some other means.

The readiest method of obtaining this gas is by the following process: Put a small piece of phosphorus in a little cup fixed to a cork floating on water, and set fire to it; while burning, hold inverted over it and dipping a little into the water, a glass jar or wide-mouthed bottle containing atmospheric air. During combustion the phosphorus unites with the oxygen of the air to form phosphoric acid, but having no affinity for the nitrogen gas, that remains nearly in a pure state, when it has either stood over the water or been agitated with that liquid, until all the white vapour of phosphoric acid has disappeared.

Nitrogen may also be separated from atmospheric air by the slow combustion, as it is termed, of phosphorus; that is, by merely exposing a stick of phosphorus, supported by a wire, in a bottle of air inverted over water.

By the exposure of moistened iron filings or iron borings to air in a bottle inverted over water; the metal oxidises, and the nitrogen gas is left: this acts even more slowly than the phosphorus in the above experiment.

By the agitation of mercury and lead in a corked bottle for a few minutes a black powder is formed, which is probably a mixture of an oxide of lead with finely-divided mercury; nitrogen gas is left.

The passing of atmospheric air over iron or, better, copper borings, heated to redness in a tube, is a useful method of preparing nitrogen when required on the large scale, but the process does not yield it in a perfectly pure state.

By exploding a mixture of 100 volumes of air and 42 of hydrogen, water is formed, and about 80 volumes of nearly pure nitrogen gas left.

Finally, nitrogen, when required absolutely pure, is best prepared by heating a mixture of chloride of ammonium and slightly alkaline nitrite of potash [NITROUS ACID], the nitrite of ammonia thus formed being split up according to the following equation:—

$$\underbrace{NH_4O,NO_3}_{\text{Nitrite of ammonia.}} \quad = \quad \underbrace{4HO}_{\text{Water.}} \quad + \quad \underbrace{N_2}_{\text{Nitrogen.}}$$

To free the gas from all traces of ammonia, it should be passed through a bottle containing dilute sulphuric acid.

Nitrogen is transparent, colourless, inodorous, and insipid. Its specific gravity is 0·9713; 100 cubic inches of it weighing 30·119 grains at 60° Fahr., the barometer marking 30 inches. Its refractive power, compared with air as unity, is 1·020; its specific heat, according to Berzelius, being 1·0247.

Nitrogen is generally considered as an electro-positive element, and in voltaic combinations is attracted to or elicited from the negative surface. Mr. Faraday has, however, found that, according to the nature of the substance decomposed, nitrogen may appear at either pole; but he concludes, that when it is evolved at the negative one it is a primary result, and when at the positive a secondary one.

Water dissolves but a very small quantity of this gas: according to Dr. Henry, 100 cubic inches take up only 1·47 cubic inches of the gas; Dr. Dalton states it to be 2·5, and Saussure 4·1 cubic inches. It is fatal to animals when respired by itself, as implied by the term *azote*; it extinguishes flame immediately; no degree of cold and pressure to which this gas has been subjected has condensed it to a fluid form.

Nitrogen resembles all other elementary bodies in being destitute of acid or alkaline powers; its affinity for substances, both elementary and compound, appears to be extremely weak, there being very few with which it combines by mere mixture, or by the action of heat under common circumstances. By electricity, however, or by the intense heat which the electric discharge excites, it may be made to combine with oxygen, and the result is nitric acid. The experiment was first made by Dr. Priestley; but the true nature of the action, and the result of it, were ascertained by Mr. Cavendish. [NITRIC ACID.]

Although the properties of nitrogen are rather of a negative than a positive description, and although its affinities are weak, yet it enters into the composition of a great number of important compounds.

With hydrogen it constitutes the alkali AMMONIA, already described; with chlorine and iodine it gives rise to detonating compounds; with carbon it forms CYANOGEN; and with phosphorus a phosphide: it also combines with some of the metals forming *nitrides*, but they are all very unstable. It enters into the composition of most animal matters except fat; is seldom a constituent of the vegetable acids, but invariably forms a part of the vegetable alkalies.

Although nitrogen itself is fatal to animals, yet it is a most important constituent of the air, serving to moderate the action of oxygen during combustion, and the too great excitement which that gas respired unmixed would produce on the animal system. It appears also from the experiments of Majendie that animals cannot live on food that contains no nitrogen.

The equivalent of nitrogen is 14; combining volume, 2.

Oxides of nitrogen.—The compounds of nitrogen with oxygen are five; their names and formulæ are:—

1. Protoxide of nitrogen . . . . . . NO
2. Binoxide of nitrogen . . . . . . NO_2
3. Nitrous acid . . . . NO_3
4. Peroxide of nitrogen . . . . . . NO_4
5. Nitric acid . . . . NO_5

1. *Protoxide of nitrogen, nitrous oxide,* or *laughing gas.* (NO.) This compound was first obtained by Dr. Priestley, who called it dephlogisticated nitrous air: he procured it by exposing binoxide of nitrogen to the action of iron, which deprived it of a portion of its oxygen, and reduced it to the state of protoxide of nitrogen. The properties of this gas were minutely examined by Davy. The best method of procuring it is to subject nitrate of ammonia to moderate heat in a retort; both the nitric acid and ammonia are decomposed, and their elementary oxygen, hydrogen, and nitrogen recombine in such proportions as to form water and nitrous oxide gas, thus:—

$$\underbrace{NH_4O,NO_5}_{\text{Nitrate of ammonia.}} = \underbrace{4HO}_{\text{Water.}} + \underbrace{2NO}_{\text{Protoxide of nitrogen.}}$$

One ounce of the nitrate furnishes about one hundred cubic inches of gas.

Protoxide of nitrogen is colourless and transparent, its smell is peculiar but rather agreeable, and its taste is sweet: 100 cubic inches weigh about 47 grains, and its specific gravity is 1·527. Water absorbs about an equal bulk of this gas, but on being heated, gives it back unchanged. It has no action upon uncombined oxygen, in which it differs remarkably from the binoxide. It is composed of one volume of oxygen and two volumes of nitrogen condensed by combination into two volumes.

Protoxide of nitrogen supports combustion, and a taper, ignited phosphorus, sulphur, and charcoal burn vividly in it; at a red heat it is resolved into its constituent gases in the proportions stated. When a mixture of one volume of this gas and one of hydrogen is fired by the electric spark, water is produced, and one volume of nitrogen remains: this shows that it must contain half a volume of oxygen, that amount being required to form water with the one volume of hydrogen.

This gas was supposed to be irrespirable, until Davy, in his 'Researches on Nitrous Oxide,' showed that it might be breathed for a short time with impunity. When required for inhalation it should be prepared from pure nitrate of ammonia, should be collected over water, and allowed to stand in contact with that liquid for a few hours. It is most conveniently taken into the lungs from an india-rubber bag, furnished with an ivory mouth piece, the passage into the bag being free and of considerable size. The effects it produces vary considerably with different individuals. After a few inspirations the body of the person usually commences to describe a kind of rolling movement, similar to that which frequently occurs under the influence of intoxication, the bag is clutched more earnestly, and inspirations taken more zealously, until in from one to three minutes the subject either suddenly rushes among the bystanders in a state of enthusiastic pugilism, or shrieks and is convulsed with laughter, or, in a condition of unstable equilibrium, stands blinking at nothing, with a grinning, semi-idiotic gaze. Protoxide of nitrogen has well earned for itself the name of *laughing gas*, not so much perhaps from the effects it produces on the patient, as from the roars of laughter elicited from those who witness its inhalation.

Protoxide of nitrogen may be obtained in the liquid state by subjecting it to a pressure of about forty atmospheres. Once compressed it may be preserved in a reservoir for two or three days, but soon begins to attack the brass or copper fittings. On opening the stopcock the first portions of the liquid freeze into a solid mass, resembling snow; but it afterwards flows freely, and being received into an open glass remains fluid for nearly an hour. During the whole time, however, it is slowly evolving gas.

Liquid protoxide of nitrogen is a colourless, mobile, and perfectly transparent fluid. A drop let fall upon the skin rapidly evaporates, producing a painful burn. Mixed with bisulphide of carbon and exposed to evaporation in vacuo, a reduction of temperature ensues to probably 252° below the freezing point of water, at all events to a much lower point than has hitherto been obtained by any other means. Metals dropped into liquid protoxide of nitrogen produce a noise as though red-hot iron were immersed in water. Mercury causes the same noise, instantly freezes and affords a hard brittle mass, of the appearance of silver. Potassium floats upon the liquid, but experiences no change, and the same is the case with charcoal, sulphur, phosphorus, and iodine: strong sulphuric and nitric acids freeze immediately; ether and alcohol merely mix with the liquid; but water is instantly frozen with an almost explosively sudden elimination of gas.

2. *Binoxide of nitrogen, deutoxide of azote,* or *nitric oxide* (NO_2). Although this gaseous body had been obtained by Hales, yet it is to Dr. Priestley that we owe the first distinct account of the method of procuring it and a description of its properties. When certain metals such as mercury, or better copper in the state of borings, are put into dilute nitric acid, they are dissolved. During their solution, owing to the partial decomposition of a proportion of the nitric acid and the absorption of its oxygen by the metal, gaseous binoxide of nitrogen is plentifully formed and evolved. It has the following properties:—it is gaseous, or permanently elastic, not having been hitherto condensed into a liquid by any degree of cold or pressure to which it has been subjected. It is colourless, and probably tasteless and inodorous; but when an attempt is made to inhale it, it excites violent spasm of the glottis by meeting and combining with the oxygen of the air, which converts it into nitrous acid gas, a very different compound. Its specific gravity is 1·039; 100 cubic inches weighing rather more than 32 grains. Water at 60° dissolves about 11 per cent. It has no action on litmus paper, nor does it in any way exhibit the properties of an acid; but as already noticed, nitrous acid is formed as soon as it comes into contact with oxygen, and then it reddens litmus paper; this property distinguishes it from all other gases whatever, and renders it a test of the presence of uncombined oxygen: this was the gas first employed by Dr. Priestley in his eudiometrical researches. It supports combustion, if the temperature of the combustible be sufficient to decompose it into oxygen and protoxide of nitrogen, thus, charcoal and phosphorus immersed in it when they are in vivid combustion, burn splendidly, but a burning candle is extinguished: sulphur also, if only sluggishly burning, is extinguished; but when its temperature is raised to near the boiling point it burns readily. It is decomposed when passed through red-hot tubes; and the same effect is produced by a succession of electric sparks. It is also decomposed when exposed to zinc or iron, which take away half the oxygen and convert it into protoxide of nitrogen. It is soluble in a solution of protosulphate of iron; the solution has a deep green or brownish colour, and has been used in eudiometry to ascertain the proportion of oxygen in gaseous mixtures; but it cannot be advantageously so employed.

It is composed by volume, of—

Fifty cubic inches of oxygen gas = 17·20 grains
Fifty cubic inches of nitrogen gas = 15·05 „
32·25 grains.

3. *Nitrous acid, hyponitrous acid* (NO_3), was discovered by Gay-Lussac, who obtained it by adding excess of binoxide of nitrogen to oxygen gas, confined in a glass tube over mercury, containing a concentrated solution of potash; under these circumstances 50 volumes of oxygen unite with 200 volumes of binoxide of nitrogen, forming nitrous acid which unites with the alkali. This acid may also be obtained by long exposure of binoxide of nitrogen gas to solution of potash, or by exposing to intense cold a mixture of 50 volumes of oxygen gas with 200 volumes of binoxide of nitrogen gas. By this operation the acid is obtained in a liquid state and possesses the following properties:—

At common temperatures it is green or blue, but at 0° it is colourless; it is very volatile, so that when exposed to the air, it is rapidly converted into an orange vapour, the density of which is stated to be 1·72. When water is added, the acid is decomposed and converted into nitric acid and nitric oxide, the latter escaping with effervescence. This acid does not readily combine with bases to form salts, being on their admixture converted into nitric acid and binoxide of nitrogen. *Nitrites* may however be formed by moderately heating certain nitrates, the acid of which then loses two equivalents of oxygen, nitrous acid remaining in combination with the base. Nitrite of potash is thus formed, the nitrate being heated until the oxygen evolved contains nitrogen. Solution of nitrite of ammonia, a convenient source of pure nitrogen, is most advantageously formed in the following way: one part of starch is gently heated with ten parts of nitric acid, and the nitrous acid gas produced passed into solution of potash, of sp. gr. 1.38, until the solution acquires an acid reaction; a little caustic potash is then added, so as to render it distinctly alkaline, and the resulting liquid when required for the preparation of nitrogen is mixed with three times its bulk of a saturated solution of chloride of ammonium, and the whole gently heated; the nitrite of ammonia formed in this process is decomposed by the heat as described above. Nitrite of lead may be formed by heating metallic lead in a solution of the nitrate of that metal. Nitrate of silver is thrown down as a white precipitate on adding together solutions of nitrite of potash and nitrate of silver; it is soluble in hot water and crystallises out on cooling.

4. *Peroxide of nitrogen* (NO_4), was long supposed to possess acid properties, and hence was called *hyponitric acid* and formerly *nitrous acid*. It may be obtained in the gaseous, liquid, or solid form.

Gaseous peroxide of nitrogen is formed on mixing binoxide of nitrogen with half its volume of oxygen in an exhausted receiver; immediate combination and condensation occur; heat is evolved; a red gas is formed, which is the peroxide of nitrogen, and when this coloured gas is subjected to a temperature of 0°, it becomes liquid, and sometimes solid. When also nitrate of lead is heated in a retort, it is decomposed, and red vapour of peroxide of nitrogen is emitted, which is condensed to the liquid state by being subjected to a freezing mixture. Towards the latter part of the operation the compound comes over in the anhydrous state, and may be obtained in crystals in a fresh, well-dried and cooled, receiver. The slightest trace of moisture prevents the formation of the crystals. Liquid peroxide of nitrogen is of a pale colour, but becomes darker when heated; it emits a very strong disagreeable odour, and at a very moderate rise of temperature reassumes the gaseous form. It is decomposed by water with strong effervescence, being immediately separated into binoxide of nitrogen, which is evolved, and nitric acid, which remains in solution.

Nitric acid (NO_5). *Azotic acid.*—This important acid may be formed by the direct combination of oxygen with nitrogen, or with any of the other lower oxides of nitrogen; by decomposition of ammonia in presence of oxygen; by the passage of electric sparks (for example, lightning) through atmospheric air, or by the EREMAUCAUSIS of organic bodies that contain nitrogen. In combination with bases nitric acid is met with in nature in great abundance: it is rare to meet with a specimen of rain-water that does not contain traces of nitrate of ammonia; most varieties of chalk contain a small quantity of nitrate of lime, and in many tropical climates, especially some parts of India and Peru, nitrates of potash and soda effloresce from the ground during the dry seasons of the year. The production of these nitrates is no doubt due to one, or a combination, of the causes already alluded to so far as the nitric is concerned, while the several bases are always at hand in the soil in the state of carbonates or other salts decomposable by nitric acid. Native nitrate of potash constitutes the crude *nitre*, or *saltpetre* of commerce, and is the substance whence we derive nitric acid itself, and most of the other nitrates.

Ordinary liquid nitric acid was known so early as the 7th century; Raymond Lully obtained it from nitre; Geber termed it *solutive water*, and Glauber manufactured it by the agency of sulphuric acid, in precisely the manner adopted at the present day. Cavendish, however, first made known its composition in 1785 [CAVENDISH, HENRY, in BIOG. DIV.], and our knowledge of it has since been perfected by Davy, Gay-Lussac, Thompson, and others. On the small scale, nitric acid is conveniently obtained by heating in a glass retort with a tolerably long neck, a mixture of equal weights of nitrate of potash and oil of vitriol; monohydrated nitric acid then distils over, and is readily condensed, while bisulphate of potash remains in the retort. The following equation represents the decomposition:—

$$\underbrace{KO, NO_5}_{\substack{\text{Nitrate of} \\ \text{potash.}}} + \underbrace{2(HO, SO_3)}_{\text{Sulphuric acid.}} = \underbrace{KO, HO, 2SO_3}_{\substack{\text{Bisulphate of} \\ \text{potash.}}} + \underbrace{HO, NO_5}_{\text{Nitric acid.}}$$

On the large scale, nitrate of soda (Chili saltpetre) is used in the place of nitrate of potash, and the process is conducted in capacious iron cylinders, coated on the upper part of the inner surface with fire-clay, to prevent the action of the nitric fumes upon the metal. Manufacturers use the soda nitrate, because it is cheaper than the potash salt, contains nine per cent. more acid, and is decomposed at a lower temperature, thereby enabling a saving in fuel to be effected. Iron retorts are used in the place of glass or earthenware, because the salt left in them can be a neutral sulphate, instead of a bisulphate, thus admitting of the use of one-half the quantity of sulphuric acid that otherwise would be necessary. Neutral sulphate of potash or of soda is, however, exceedingly hard, and being but sparingly soluble in water, has to be detached from vessels containing it by the use of iron tools, a proceeding somewhat hazardous if those vessels are of glass or earthenware.

As obtained by the above process, nitric acid is a colourless, transparent liquid, of sp. gr. 1·520. One hundred parts contain 85·72 of anhydrous nitric acid (NO_5), and hence its composition is expressed by the formula HO, NO_5. It boils at 184° Fahr., and freezes at −40°. Exposed to the air it continues to fume very strongly until it has absorbed sufficient water to constitute it a terhydrate ($HO, NO_5 + 3$ Aq.): this is the condition of maximum stability of aqueous nitric acid; a weaker acid loses water on boiling until the state of terhydrate is reached, a stronger acid losing nitric acid under the same circumstances. Terhydrated nitric acid has a sp. gr. of 1·424, contains sixty per cent. of anhydrous acid, and boils at 250° Fahr. Nitric acid readily absorbs the lower gaseous oxides of nitrogen, forming a yellow, or even red, fuming liquid, known by the name of *aqua fortis*. It also becomes of the same colour when any organic matter, such as a piece of straw or paper is allowed to fall into it; even mere exposure to sunlight will produce the same decomposition. The chief cause of the instability of nitric acid is the readiness with which it parts with a portion of oxygen; indeed, as an oxidising agent, it is in constant request by the chemist. Metals thrown into it are rapidly converted into oxides with evolution of binoxide of nitrogen and production of orange-red nitrous fumes, a reaction taken advantage of in testing for the presence of nitric acid; sometimes the binoxide of nitrogen is made to pass into solution of protosulphate of iron, in which it dissolves with formation of a black compound, a reaction that is even more delicate than that with the copper turnings; it is performed as follows. Into the liquid suspected to contain nitric acid, or a nitrate, a few crystals of protosulphate of iron are placed, and the whole is agitated for a minute or two to facilitate the solution of a little of the salt; strong sulphuric acid is now cautiously poured down the sides of the vessel, and being heavy flows on to the crystals at bottom, and at once gives rise to the black compound in question if a trace of nitric acid be present. The cause of the production of the compound is the oxidation of a part of the protosalt of iron to a persalt by the nitric acid, binoxide of nitrogen being evolved, and combining with the undecomposed protosulphate; the use of the sulphuric acid is to liberate nitric acid from combination, and to facilitate the formation of the persulphate of iron.

Nitric acid is one of the most corrosive substances known; it permanently stains the cuticle of a yellow colour, and in a similar way attacks wool, feathers, and all animal matters that contain albumen. Its strength is most readily ascertained by taking its specific gravity, and then consulting such a table as the following, an abridgement of one constructed by Dr. Ure:—

Specific gravity.	NO_5 in 100 parts by weight.	Specific gravity.	NO_5 in 100 parts by weight.
1·5000	79·700	1·2887	39·053
1·4940	77·303	1·2705	36·662
1·4850	74 918	1·2523	34·271
1·4760	72·527	1·2341	31 880
1·4670	70·136	1·2148	29·489
1·4570	67·745	1·1958	27·098
1·4460	65·354	1·1770	24·707
1·4346	62·963	1·1587	22·316
1·4228	60·572	1·1403	19·925
1·4107	58·181	1·1227	17·534
1·3978	55·790	1·1051	15·143
1·3833	53 399	1·0878	12·752
1·3681	51·068	1·0708	10·361
1·3529	48·617	1·0540	7·970
1·3376	46·226	1·0375	5·579
1·3216	43·835	1·0212	3·188
1·3056	41·444	1·0053	0·797

Anhydrous Nitric Acid (NO_5). This was first obtained in brilliant, colourless, transparent, prismatic crystals, by M. Deville. The method of operating consists in passing a slow current of perfectly dry chlorine gas over pure crystals of nitrate of silver heated in an oil bath, and connected with a receiver made cool by a freezing mixture. The decomposition that takes place is thus expressed,—

$$\underbrace{AgO, NO_5}_{\substack{\text{Nitrate of} \\ \text{silver.}}} + \underbrace{Cl}_{\text{Chlorine.}} = \underbrace{AgCl}_{\substack{\text{Chloride} \\ \text{of silver.}}} + \underbrace{O}_{\text{Oxygen.}} + \underbrace{NO_5}_{\substack{\text{Nitric} \\ \text{acid.}}}$$

In order to ensure success a number of precautions must be observed, for which see M. Deville's paper ('Ann. de Chimie,' III, xxviii. 241).

Nitrates. Salts formed by the union of nitric acid with a base; the number of equivalents of each being usually equal, never containing more acid than base, but frequently more base than acid. They are nearly all decomposed when strongly heated, deflagrate when thrown on to ignited carbon, and are mostly soluble in water.

Hydrides of nitrogen. Nitrogen united with two equivalents of hydrogen forms the hypothetical substance *amidogen*, a body that united with metals and electro-positive radicals, forms AMIDES. Nitrogen with three equivalents of hydrogen forms AMMONIA, and with four equivalents the compound radical *ammonium*.

Phosphide of Nitrogen (N_2P). Dr. Pauli states ('Ann. der Chem. u. Pharm.,' ci. 41), that when an intimate mixture of pentasulphide of phosphorus and chloride of ammonium is distilled, a light powder of slightly yellow colour is obtained as a residue, which is phosphide of nitrogen. It is insoluble in water and nitric acid, and when melted with potash evolves ammonia.

Sulphide of Nitrogen (NS_3). A compound formed by the re-action of protochloride of sulphur, ammonia and water. It exists in two isomeric states; in the one it is of a light green colour, in the other it is yellow. It crystallises from solution in hot ether, is inodorous and has but little taste.

Iodides of Nitrogen. [IODINE, *nitrogen and.*]

Bromides of Nitrogen. [BROMINE, *nitrogen and.*]

Chloride of Nitrogen. [CHLORINE, *nitrogen and.*]

NITROHEMATIC ACID ($C_{12}H_5(NO_4)_2NO_2$) *Picramic Acid.* This acid was discovered by Wöhler. Its name is derived from *hæma* (ἁιμα), *blood*, in allusion to the colour of its salts. It is prepared by mixing carbazotic or nitropicric acid with protosulphate of iron and digesting the mixture with hydrate of barytas and water. The protoxide of iron separated, becomes peroxide at the expense of the nitropicric acid, and a new acid is formed, which is the nitrohematic acid; it is separated by a tedious process from the baryta with which it combines as it is formed, and then has the following properties:—

It has the form of small brown crystalline grains, and scarcely any taste; when exposed to a moderate heat, it begins to liquefy and afterwards detonates without the evolution of light, but with the formation of cyanide of ammonium and the deposition of carbon, which burns without leaving any residue. It is but slightly soluble in water, and the solution is yellow; it dissolves in nitric acid.

With bases it forms peculiar salts, the solutions of which are of a deep blood red colour; but when dry, they are of a deep brown with a tint of green and a semimetallic lustre; the alkaline and earthy salts of this acid have a bitter taste, and when heated they detonate like gunpowder. The nitrohematate of ammonia has rather a crystalline appearance, and when heated it detonates with the evolution of light, and the formation of much cyanide of ammonium.

NITROHYDROCHLORIC ACID. *Nitromuriatic Acid. Aqua Regia.* A powerfully corrosive liquid, formed on mixing one measure of nitric acid with about three of hydrochloric acid. The alchemists called it aqua regia, from its property of dissolving gold, their "king of metals." It also attacks and dissolves platinum, and of course exerts the same action on all those metals that are soluble in nitric acid or hydrochloric acid separately; perchlorides in all cases being formed.

The solvent action of nitrohydrochloric acid has been shown by M. Gay-Lussac to be due to free chlorine. At least two other bodies are, however, produced simultaneously with the chlorine; they are rich in chlorine, but do not act upon metals; the one is chloronitric gas, the other chloronitrous gas.

Chloro-nitric Gas. ($NO_2\,Cl_2$). This gas constitutes the yellowish-red fumes that are evolved when nitrohydrochloric acid is gently heated. Passed through a tube surrounded by a freezing mixture it condenses to a cloudy lemon-coloured liquid. Its formation is attended with evolution of chlorine, as indicated by the following equation:—

$$\underbrace{NO_5}_{\substack{\text{Nitric}\\\text{acid.}}} + \underbrace{3HCl}_{\substack{\text{Hydrochloric}\\\text{acid.}}} = \underbrace{NO_2Cl_2}_{\substack{\text{Chloro-nitric}\\\text{gas.}}} + \underbrace{3HO}_{\text{Water.}} + \underbrace{Cl}_{\text{Chlorine.}}$$

Chloro-nitric gas is decomposed by water, chlorine and peroxide of nitrogen remaining in solution. It readily acts upon mercury but is not an acid, and does not combine with bases. It may be viewed as peroxide of nitrogen (NO_4) in which two equivalents of oxygen are replaced by two of chlorine.

Chloro-nitrous gas. (NO_4Cl). This gas comes off in greatest abundance towards the latter part of the operation of boiling nitro-hydrochloric acid. It may also be obtained directly by allowing binoxide of nitrogen and chlorine to condense together in a vessel surrounded by a freezing mixture. Like chloronitric gas it is decomposed by water, and though not itself an acid may be viewed as nitrous acid (NO_3) in which an equivalent of oxygen is replaced by one of chlorine.

NITROLEUCIC ACID. [Leucin.]

NITROMURIATIC ACID. [Nitro-hydrochloric Acid.]

NITROSO-NAPHTHYLIN. [Naphthalic Group.]

NITROSO-PHENYLIN ($C_{12}H_6N_2O_2$), an organic compound formed by the reducing action of zinc and hydrochloric acid upon binitrobenzole. It cannot be crystallised, but its alcoholic solution dries down to a brilliant black pellicle, which is nearly insoluble in water, but readily soluble in acids and alcohol. Its solution possesses a magnificent crimson colour.

NITROPICRIC ACID. [Carbazotic Acid.]

NITROPRUSSIDES. [Cyanogen.]

NITRO-QUERCITE. [Mannite.]

NITRO-SULPHURIC ACID. [Nitrogen.]

NITRO-THEINE. [Caffeine.]

NITROUS ACID. [Nitrogen.]

NITROUS ETHER. [Ethyl.]

NITROUS GAS. [Nitrogen.]

NITROUS OXIDE GAS. [Nitrogen.]

NIZAM, the title of the sovereign of Hyderabad, derived from Nizam-ul-Mulk, who, after the death of Aurungzebe, obtained possession of the Mohammedan conquests in the Deccan, his name being assumed as a title by his successors in the sovereignty. After reigning 31 years, Nizam-ul-Mulk died at a very advanced age, in 1748. He was succeeded by his second son Nassir Jung, who was assassinated in 1750. His grandson Muzuffer Jung was then placed on the throne, and also assassinated in the year following. The third son of Nizam-ul-Mulk, Salabat Jung, then reigned until 1763, when he was put to death by his brother Nizam Ali, who thereupon took the reins of government, and held them till his death in 1803. His successor, Sekundar Jah, died in 1828, and was succeeded by Nazir-ud-Doulat, who died May 16, 1857. The present nizam is named Afzal-ul-Doulat. Under this prince the misgovernment attained so great a height, and the debt to the British government became so large, that a territorial cession was effected; the revenue of the sequestrated districts to be applied to the reduction of the debt and the maintenance of the military contingent.

The nizam is one of the native sovereigns with whom the East India Company made subsidiary treaties, and to which the British government by the cession of the Company's political power succeeded. The chief provisions contained in these treaties are—1st, protection by the British government against all enemies, foreign or domestic: 2nd, mutual co-operation in the event of hostilities with other powers; 3rd, the maintaining of a British force for the protection of the native state; 4th, the reception of a British resident, by whose counsel the native government is bound to abide as regards all public affairs, internal and external; and 5th, the abandonment on the part of the native prince of all political intercourse with other powers, except through the medium of the British government. Under this system the native princes are little more than viceroys, who administer the government according to the views of their superior; and in fact the British residents appointed under subsidiary treaties are not so much ambassadors as they are ministers. Connected closely with the presidency of Bombay, Hyderabad was not engaged in the mutiny of the native Indian troops in 1857-8, and consequently its political position remained unchanged.

NOBILITY. The slightest attention to the nature and the actual experience of man must convince every one that society has a tendency to inequality in the condition of the persons composing it. Take half a dozen youths, and place them in a society apart from all other persons of their kind; place them under no other condition than that each person shall enjoy what is his own in his own way; let the whole be at first as nearly on an equality as possible in respect of advantages which are not those of mere nature; and it is certain that at the end of fifty years they and their families will be in a state of great inequality, that some one among them will have attracted to himself more of the things which make life easy than any of the rest, and that there will be not only a difference but a very great difference between the most and the least successful of the party.

This arises from the inequality of the physical, the moral, and intellectual power of each, that is, of some one of those things which we say are the gifts of nature, combined with the introduction of principles and habits at a very early period of life, the things in short which make the man himself, independently of the adventitious advantages which are derived from the possession of things external to himself.

Thus bodily strength, adroitness, quickness of eye, capacity of bearing fatigue, steady industry, frugality, temperance, caution, foresight, aptness to seize opportunities, knowledge of the dispositions and characters of other men, will in any situation of life prove advantageous to those who possess them; and those who want them and are without an equivalent in some other valuable quality, can never expect to be in a situation equally favourable, when time has been allowed for the exercise of those faculties and for the production of their natural fruits.

When once a little advantage is gained, and another generation arises starting in life with the possession of the advantages which the talent or the good fortune of the father secured for it, if the same good physical, moral, or intellectual faculties are inherited, as may be the case, it is manifest that the elevation will become higher and the distinction greater. This will go on in an accelerating ratio, for the adventitious advantages operate as in a series of compound interest. On the other hand there may be a declension in another, till the lowest possible point of destitution has been reached. It seems that if once the principle of *property* is admitted, and every man is guaranteed in the possession of that which belongs to him, what we have described must necessarily take place. Society may by its institutions do something to restrain this tendency, or something which shall in its effects promote it; but society can never preclude it, except by measures which shall annihilate *property*. Whether such measures can be desirable, it is not our present business to discuss.

It is thus, we conceive, that the distinction of *nobiles* and *vulgars*, which we find in the earliest records of human society, must have originated.

Political consideration and political power will in some degree always follow wealth; and thus it has been that a larger share of influence in the direction of the affairs of a community has always fallen to the lot of those in whose hands, by their own exertions or those of their ancestors, a larger share of adventitious advantages had been accumulated than in the hands of others less able or less fortunate.

Nobility, in the earlier stages of civilisation, consisted, it is probable, in nothing more than the union of political power with wealth; but this would soon pass into that other state in which we in Europe now see it, where the particular political advantages were guaranteed to the family of him who once possessed himself of them, by which means there was created a new and very important distinction in society, and it became necessary that society should define who the persons were that were admitted by it to such desirable privileges. It was not now the mere possession of wealth and of that political power which will always more or less attend wealth which made a man *nobilis*; there must be some recognition of his admission into what constituted an order endowed with such privileges. Being once secured as an hereditary possession, these privileges might fall to persons who had not wealth or the means of obtaining it, nor the influence and power which wealth brings with it.

When once society had thus established an order and regulated the means by which persons might be admitted into it, the desire would become general of admission to the privileges and advantages which belonged to it, in persons who had any pretensions to aspire to such advantages. It was then easily discovered that society had thus an unexpensive way opened to it of rewarding very eminent services. A community has not always manors and lands to give to the man who performs for it such services, nor are money pensions out of the taxes, continued from generation to generation, agreeable to those who contribute to the payment of them. But a society accustomed to such an order, and sensible of the benefits which attend the existence of such a state of things, willingly sees advanced into it men who are distinguished by very eminent talent, very eminent services, or very eminent virtues. It is a reward not given all at once, but through a long succession of years.

In the different countries of modern Europe there are nobles various in their titles and various in the privileges belonging to them. In England, Scotland, and Ireland, the heads of the families which are noble are either dukes, marquesses, earls, viscounts, or barons; all, except the last, originally names of office, originated in that state of society where the *nobiles* were all men in actual political employment. To the heads only are political privileges given, the chief of which is, that the English peers have seats in the House of Lords, and consequently a voice in all projected changes of the law. But the junior members of the family are accounted noble, and have certain titles or honourable distinctions united with their names.

By the English constitution the privilege of placing a family in the rank of the nobility is vested solely in the sovereign. The phrase by which this is usually expressed is, that the sovereign is the fountain of honour. It is done by letters-patent declaring that such or such a person is created to the dignity, &c., to descend to the heirs male of his body, or in such manner as the crown may choose to direct.

The persons admitted into the order of nobility in England are now usually—1, Peers of Scotland or Ireland; 2, Persons distinguished for services in the army, navy, diplomacy, and for political services; 3, Younger branches of families already noble; 4, Persons of ancient wealth, with sometimes, though rarely, persons of large fortunes which have been recently acquired; and 5, Persons promoted to high judicial appointments, as the lord chancellor, the chief justice of the King's Bench, and others, usually called the law-lords.

New creations are essential to keep up the order, as extinction is perpetually taking place in a nobility such as the English, where few of the titles descend in any other way than to the male descendants of the person first ennobled.

There are modern communities, such as the United States of North America, in which there is no nobility in any respect resembling that of Europe. Wealth of course gives some influence and importance to the possessor, but it is also an object of jealousy, which must always be the case, more particularly in democratic constitutions. Office, so long as it is held, gives greater distinction than wealth; but office is only held for a short time, and wealth, although it may be acquired by an individual, is seldom transmitted to a single person, but is usually distributed in moderate or small portions among several persons. Thus it has been observed, that in the United States a family seldom maintains any great wealth or importance for more than two generations. Names which have been made illustrious by an individual are remembered only because of him who first elevated them to distinction, and the descendants of the wealthy lose with their wealth the remnant of that importance which their ancestor acquired. Thus one family of distinction after another sinks into obscurity, and its place is soon filled by a name before unknown.

NODAL POINTS AND LINES. Nodal points are those points in the length of a string extended between two fixed objects, or in a column of air confined at one or at each extremity, which, when the string or column is put in a state of vibration, are found to remain at rest; nodal lines are corresponding lines which exist on the surface of an elastic body, usually a plate, whose parts are in a state of vibration.

It is well known that if a string or a metallic cord be attached at its extremities to a board or plate, on causing it, when in a state of tension, to vibrate transversely, there may be distinguished, besides the principal sound, which is due to the length of the string, several others which have a greater degree of acuteness; these are called *harmonic sounds*, and they are conceived to result from some property of the extended string, by which, when in a state of vibration, it becomes a sort of moving axis, having on it points, at distances from one another equal to some aliquot part of the whole length of the string, at which points a contrariety in the directions of the vibrations of the particles keeps the latter in a state of rest. Such are called *nodal points;* and they may be conceived to form themselves in consequence of inequalities in the thickness or density of the string, or of different degrees of flexibility in its different parts. The string between every two such points is in the same condition as if it were attached at those points to fixed objects; its partial vibrations are consequently such as are due to the distances between the points, and hence arise the secondary or harmonic sounds.

A string of considerable length, on being made to vibrate, will be found to have several such nodal points, and the curves which the intervals assume in consequence of the vibrations, though alternately on opposite sides of the axis of the string, are equal and similar to one another. The situations of the nodal points may be made evident by placing, at intervals, across the string, pieces of paper notched or bent in the form of an inverted V; those which are at the places of the nodes remaining at rest, while the others experience considerable agitations, or are thrown entirely off.

If a string, in a state of tension, have its extremities attached to a board or plate of metal, and be made in some part of its length, to pass over a bridge resting in the centre of the board or plate, the vibrations of the string, when a violin-bow is drawn across it, will be communicated to the plate; and if over the latter some light dust or powder such as fine sand or lycopodium be sifted, that dust will be agitated and made to arrange itself on lines at which the surface of the plate is in a state of rest: these are called *nodal lines*, and the figures which they form are called *Acoustic figures*. Again, if a glass rod be cemented at one end to the centre of a disk of the like material, and be excited by being rubbed, for example, with a wet cloth, so as to be put in a state of vibration longitudinally, those vibrations will be communicated to the disk, and light dust strewed over the latter when in a horizontal position will arrange itself in acoustic figures. Or, if a glass rod be connected at each extremity to a glass disk at right angles to its length, on exciting one of the disks by drawing a violin-bow across its edge, the vibrations of that disk will, by means of the rod, be communicated to the other; and if light dust be strewed over both it will arrange itself in figures: when the disks are equal and similar to one another, the figures are alike on both; otherwise they differ.

If a column of air in a cylindrical tube which is closed at either or at each end be acted upon by the force of the breath, for example, applied at an aperture in any part of its length; it will spontaneously divide itself into portions in which the particles are subject to equal and similar vibrations [ACOUSTICS; VIBRATION]: these portions are separated from one another by sectional areas in which the particles are at rest; the condensations, or rarefactions, of the air being, in those areas, greater than in any other parts of the tube in consequence of the particles moving in contrary directions, and with equal velocities towards, or from, them. Such areas are called *nodal sections*, and several may exist at the same time in the tube. Their existence is rendered evident by boring small holes in different parts of the sides of the tube and covering them with pieces of thin paper slightly adherent to the surface: at the nodal sections the papers will be scarcely affected, while, in the intervals, they will be greatly agitated.

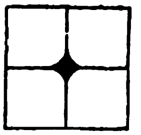
If, in the side of a tube containing a column of vibrating air, any aperture exist by which that air is enabled to communicate with the atmosphere, the air in that section becomes in equilibrio with the latter, and, in that section, there is consequently neither condensation nor rarefaction: this section corresponds to the middle point between two nodes in a vibrating string.

Vibrations corresponding to those which are produced in strings or rods and in columns of air may be conceived to take place in any solid bodies or in any elastic fluids whatever be the figure of their mass: in such a mass there may be several places at which the vibrations are performed in contrary directions so as to produce nodal lines; and these, when they occur on the surface of the mass, may become sensible by means of light dust strewed over it. Some of the vibrations are found to take place parallel to the surface, and others perpendicular to it: the former being called *tangential*, and the latter *normal* vibrations. In one case the particles of dust glide upon the surface in directions which tend alternately towards and from the nodal lines (the movements in the former direction being always more rapid than those in the other) till they come to a state of rest on those lines; in the other case the particles alternately rise from and fall back upon the surface at the places where the latter is in a state of vibration; and, dispersing from those places, they become quiescent in the lines of no vibration.

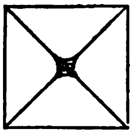
Galileo was the first who observed (*Dialoghi delle Scienze Nuove*) that the vibrations of elastic plates might be rendered visible by covering the plates with fine sand; and he remarked that the sand became accumulated at the parts where the vibrating plate was in a state of rest: but this subject was extensively investigated by Dr. Chladni, of Wirtemberg, who first discovered the longitudinal vibrations of solid bodies; and, 1787, published, in a work entitled *Entdeckungen über die Theorie des Klanges*, an account of numerous experiments which he had made on the nature of the vibrations produced in plates of glass of different forms.

The plates with which such experiments may be performed should be of good window glass; and, if square, from 4 to 8 inches on each side; if circular, their diameters may be within the same limits: in making an experiment the plate must be held horizontally between a finger and thumb, or it may be fixed within the lips of a clamp screw or of suitable tongs, the points of contact being furnished with cork; and when it is required to prevent any particular part of the plate from vibrating, that part, if on the edge, may be pressed against a fixed object, or, if at any part of the surface, one of the fingers of the hand may be pressed gently upon that part. The plate being in a horizontal position, it must be covered with a layer of fine dust such as lycopodium; and it may be put in a state of vibration by drawing a violin-bow across its edge: the dust will then arrange itself in figures which will vary with the form of the plate, the place at which the bow is applied, and that at which the plate is held. If, for example, a square plate be held at its centre, and the bow be applied near one of the angles, the dust will arrange itself in lines so as to divide the plate into four equal squares (No. 1). If the plate be held as before, and the bow be applied at the middle of one of the sides, the vibrations will be such as to make the dust lie in the direction of the two diagonals (No. 2). Again, if the plate be held at A (No. 3) and the bow be applied at B, the dust will assume the positions of three lines parallel to one another: and if the plate be held at a point nearer the edge, the lines will become curves, as in No. 4.

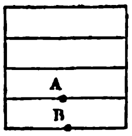
No. 1.



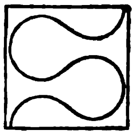
No. 2.



No. 3.

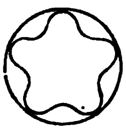


No. 4.

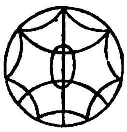


If a circular plate, held at the centre, be pressed against a fixed object at any point on its circumference, and the bow be applied at 45° from that point, the lines will take the positions of two diameters at right angles to one another, one of them passing through the point at which the circumference touches the object. A greater number of radiating lines than four will be produced if the bow be drawn more rapidly and with less pressure against the edge of the plate than in the former case. If the centre of the circular plate be free, various curve lines will be assumed by the dust, according to the position of the point which is held; and one of them is represented in No. 5. The figures represented in Nos. 6, 7, and 8, are selected from the great number which Chladni has obtained with glass plates of a circular, a polygonal, and a triangular form. Professor Wheatstone has calculated a large number of these acoustic figures by the principle of the superposition of small motions. (Phil. Trans.) Professor Faraday also describes (Phil. Trans., 1831) a number of interesting experiments on the subject.

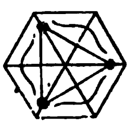
No. 5.



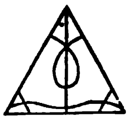
No. 6.



No. 7.



No. 8.



Beautiful acoustic figures may also be obtained on the surface of mercury, water, spirit, &c., contained in a glass goblet, by drawing a violin-bow against its edge. This part of the subject is fully and carefully investigated in Mr. Tomlinson's 'Student's Manual of Natural Philosophy,' (1838). M. Felix Savart has observed, that if a rectangular plate of glass about 27 inches long, ⅞ inch broad, and $\frac{1}{12}$ inch thick, be held horizontally between a finger and thumb at the middle of its opposite edges, and it be put in a state of longitudinal vibration, either by rubbing its under side, near one of the ends, with a wet cloth, or by striking it gently at one end, the dust on the upper surface will arrange itself in lines perpendicular to the length of the rod. It is remarkable, that if the plate be turned with its upper face downwards, being held as before, and vibrations be produced in like manner, the places of the nodal lines will be opposite to the middles of the intervals between the lines observed in the other position of the plate—a circumstance which proves that the motions of the particles in one-half of the thickness of the lamina of glass are directly contrary to those in the other half. A like effect has been observed when cylindrical rods of glass have been made to vibrate longitudinally; the lines of nodes then assuming a spiral form about the cylinder, and the curves consisting of portions which run alternately in contrary directions: the points of greatest and least inclination to the axis of the cylinder are at 90° from each other with respect to a line drawn on the surface parallel to the axis, and the effect is such as would arise if the cylinder were divided longitudinally into four quadrantal portions, having opposite qualities. The places of the nodes on that part of the rod which was uppermost were found, the rod being held in a horizontal position, by annular pieces of paper loosely encircling it.

In 1822, M. Savart read to the Académie des Sciences at Paris, an account of some curious experiments in which acoustic figures were produced in consequence of vibrations communicated through the air to elastic membranes. ('Brewster's Edinburgh Journal of Science,' vol. ii., p. 296.) A sheet of thin paper was slightly stretched over a glass vessel four or five inches in diameter, and on it was strewed light dust. A thin circular plate of glass, in a state of vibration, was then brought within a few inches of the paper, when the vibrations were communicated to the latter, and, the paper being of uniform thickness and well stretched, the dust assumed figures which were perfectly regular. M. Savart, having rendered the glass plate immoveable at opposite points on its circumference by holding it there between the thumb and a finger of each hand, placed the tip of another finger at a point on the surface, at a distance from the centre equal to about one-fifth of the diameter, and caused the plate to vibrate by drawing a violin-bow across its circumference. In these circumstances, on presenting the plate to the stretched paper, the following appearances were observed. The nodal figures on square paper were analogous to those formed on a square plate of glass or metal, and on circular plates their general character was circular. The circular lines were sometimes cut by diametrical lines which formed nodal points, or stars, and the number of these increased with the acuteness of the sound produced by the bow. When the plate of glass was parallel to the paper, the nodal lines were similar on both, as when two plates were connected with each other, by a rod fixed perpendicularly between them. When the plane of the glass plate was held vertically, the nodal lines on the paper became parallel to one another; and the figures on the paper changed as the glass plate was made to decline from the vertical position.

Some curious acoustic figures have been produced by M. Lissajoux by attaching a mirror to one of the prongs of a tuning fork, and allowing a ray of light to fall somewhat obliquely on the mirror. It is evident that under such circumstances the direction of the reflected ray will change with every vibration of the fork, and on allowing this reflected ray to fall on the screen, the vibrations of the fork become visible in the rapid motions of a point of light on the screen. In this way M. Lissajoux has rendered the vibratory movement of solid bodies visible and has made evident the optical composition of vibratory motions which take place in the same direction: he has also been able to compound two vibratory motions at right angles to each other; to show the accordance of two diapasons separated by a musical interval, and to give the means of fixing on a constant or invariable fundamental sound. The only fault of this highly suggestive method is that it does not leave a permanent trace of its indications.

NODE. The points of a planet's or comet's orbit in which it cuts the ecliptic, and the points in which the orbit of a satellite cuts that of its primary, are called the nodes of such planet, comet, or satellite. Generally, the point in which one orbit cuts a second is called the node of the first *upon* the second.

NOLLE PROSEQUI is a phrase used in proceedings at law to denote the withdrawal of the plaintiff from the further prosecution of his suit, and is derived from the words used in the formal entry of such withdrawal on the record, in which the party "acknowledges that he will not further prosecute" (fatetur se ulterius *nolle prosequi*), the consequence of which is that the defendant is entitled to his costs, under stat. 8 Eliz., c. 2, s. 2. In equity, the complainant can at any time discontinue his suit upon an application to the court, and paying the costs of the defendant, as he likewise may do at law. In criminal prosecutions by indictment, which are in the name of the Crown, though originated by private persons, a nolle prosequi may be entered by the attorney-general, but not without his concurrence, although the prosecutor desires it. It is very unusual however for the attorney-general to enter a nolle prosequi upon an indictment, except upon the application of the prosecutor. Lord Holt says, "the practice began in the reign of Charles II., and that in all Charles I.'s time there was no precedent of a nolle prosequi upon an indictment." (6 *Mod. Rep.*, 262.) There can be no doubt of the power of the attorney-general to put an end to criminal *informations* filed *ex officio* by him; and in the case of informations in the Court of Queen's Bench, a nolle prosequi may be entered by the master of the crown-office upon the application of the prosecutor and with the leave of the court. The effect of a nolle prosequi in criminal cases is to discharge the defendant for the time, but it does not operate as an acquittal; so that he may be indicted again, and it is said that even upon the same indictment fresh process may be awarded.

NOMENCLATURE, CHEMICAL. [CHEMICAL NOMENCLATURE.]

NOMINALISTS, a sect of the scholastic philosophers, so named on account of the particular tenet by which they were distinguished, and in opposition to the Realists, another scholastic sect. In order to understand the principal point of difference between these parties, which gave rise to long-continued and acrimonious disputation, it is necessary to advert to the doctrines of the ancient philosophy concerning ideas or universals. According to Plato, who appears to have been indebted for his opinion to the Pythagorean school, universals, or, as he called them, ideas, by which are to be understood such things as we express by general terms, have, apart from the mere conception of them by the understanding, an actual and eternal existence in the Divine Mind; and are the patterns or models according to which the individuals of every species are formed, and by which the constitution of each individual is determined. The separate existence of these essences was denied by Aristotle, who taught that forms—which word as employed by him has the same meaning with the ideas of Plato—were eternally united to matter; that unconnected with it they have no existence, and that they are inherent in their objects. Zeno and the Stoics generally ridiculed the belief in such universal natures altogether; and held that the forms of the Stagyrite and the ideas of his preceptor were nothing if distinguished from the notions of them in the mind and the words by which they are designated. The doctrine of Aristotle was universally received among the schoolmen until after the commencement of the 11th century. But with the revival of dialectic science, which about this time occurred, it began to be warmly controverted. Those who adopted the Stoical doctrine, and affirmed that words or names only were universal, were termed Nominalists; while those who adopted the Peripatetic opinion, and maintained the proper existence of universals, were termed Realists. The honour of forming the sect of the Nominalists is commonly assigned to Roscelin, canon of Compiègne; but its real founder appears rather to have been John, called the Sophist, and supposed by Du Boulay, the historian of the Parisian Academy, to have been chief physician to king Henry I. of France. Be this however as it may, to Roscelin unquestionably belongs the credit of having first raised the sect into eminence. The Nominalist doctrine was highly obnoxious to most of the divines as well as the philosophers of the period, chiefly perhaps, as Brucker supposes ('Historia Critica Philosophiæ'), on account of Roscelin having employed it in illustrating the mysterious constitution of the Divine Nature, and thereby laid himself open to the charge of heresy. Notwithstanding the opposition originating in this source which it encountered, many converts were made; and its advancement was greatly promoted by the genius and learning of the celebrated Abelard, who was one of the disciples of Roscelin. So successful was he in his disputes with William de Champeaux, styled the 'Venerable Doctor,' who flourished about the beginning of the 12th century, and was then the principal supporter of Realism, that the pupils of the latter in large numbers forsook their master, and became the followers of his more eloquent antagonist. Throughout the whole of the 12th century the contest between the rival sects continued to be waged. Both parties, by various modifications of their leading doctrines, gradually became divided to a considerable extent among themselves, and a third sect arose, professing to steer a middle course between them, the adherents of which were distinguished by the name of Conceptualists, on account of their holding universality to be the attribute, not of names only, but of conceptions. This sect however obtained but a small share of notice. At this period the Realists, both in number and respectability, had the advantage of their opponents, and the erudition and subtlety of Albert the Great, Thomas Aquinas, and afterwards of Duns Scotus, gave them such a decided predominance, as to throw the Nominalists completely into the shade. In the 14th century William Occam, an English Franciscan friar, and a pupil of Scotus, becoming the advocate of Nominalism when it was seemingly about to expire, effected a revival, and brought it into greater repute than it had ever before enjoyed. The discussion of the question respecting universals was once more renewed, with the utmost virulence and animosity on both sides. Blows were resorted to when argument was exhausted; and not unfrequently debates were terminated by bloodshed. Throughout Germany the opinion of the Nominalists was soon almost universally received, while Realism, being supposed to be more consistent with the doctrines of the church, and patronised by successive popes, prevailed in Italy and other countries where the influence of the Roman see was most powerfully felt. Although numbering among its defenders fewer persons of philosophical eminence than were to be found among the leaders of the opposite cause, it still maintained its wonted predominance. John, the twenty-third pope of that name, having finished his disputes with the Franciscans, who had zealously opposed him on certain matters affecting the privileges of their order, directed severe persecutions against the Nominalists. In the year 1339 the university of Paris published an edict, denouncing the philosophy of Occam, the effect of which however does not seem to have been very hostile to its wider extension. Louis XI., of France, in 1473, likewise issued an edict against the Nominalists, in which it was ordered that their writings should be seized and secured in the libraries by iron chains, to prevent their being perused. The consequence was, that the leaders of the sect fled to England and Germany. In the following year Louis mitigated his edict, which he had issued at the suggestion of the bishop of Avranches, and permitted the study of the Nominalist writings. Thereafter this sect obtained the ascendancy in the universities of France, as it had formerly obtained it in those of Germany. The Reformation, to which a long train of causes had been effectually conducting, put an end to the controversy so long and so fiercely carried on between the two most memorable parties that have ever arisen among the schoolmen, and the contemporaneous revival of letters eventually gave the death-blow to the scholastic philosophy. Among the most eminent supporters of Nominalism, besides those already referred to, may be mentioned Suisset, Buridan, Marsilius ab Inghen, and Oresmius, in the 14th century, and Matthew of Cracow, Gabriel Biel, Gerson, &c., in the fifteenth.

NOMINATIVE. [Case.]

NONAGESIMAL. The nonagesimal degree of the ecliptic is that point of the ecliptic which is highest above the horizon. Every point of the ecliptic is therefore the nonagesimal degree in succession.

NONAGON. [Polygons, Regular.]

NONCONFORMITY is the term employed to designate Protestant dissent from the Church of England. It was in the reign of Edward VI. that the English reformed church first received a definite constitution. During the time of Henry VIII. it remained in a great measure unsettled, and was subject to continual variation, according to the caprice of the king. As organised by Edward, while Calvinistic in its creed, it was Episcopalian in its government, and retained in its worship many of those forms and observances which had been introduced in the days of Roman Catholic ascendancy. In the first of these particulars it resembled and in the last two it differed from the Genevan church. During the temporary restoration of the Roman Catholic faith under the administration of Philip and Mary, great numbers of the persecuted disciples of the reformed faith sought refuge in France, the Netherlands, Switzerland, and other parts of the Continent. Of those who fled to Germany, some observed the ecclesiastical order ordained by Edward; others, not without warm disputes with their brethren, which had their commencement at Frankfort, adopted the Swiss mode of worship, preferring it as more simple, and more agreeable to Scripture and primitive usage. Those who composed this latter class were called Nonconformists. The distinction has been permanent, and the name has been perpetuated. Queen Elizabeth's accession to the throne, in 1558, opened the way for the return of the exiles to the land of their fathers. It was natural for each of the parties of which they consisted, to advocate at home the systems of worship to which they had been respectively attached while abroad; and the controversy, which had been agitated by them in a foreign country, immediately became a matter of contention with the great body of Protestants in their own. It suited neither the views nor inclinations of the illustrious princess who then held the sceptre to realise the wishes of the Nonconformists, or Puritans, as they began to be called, by giving her sanction to the opinions which they maintained, and assenting to the demands which they made. The plain and unostentatious method of religious service which they recommended did not accord with that love of show and pomp for which she was remarkable; and the policy of the early part of her reign, in which she was supported by the high dignitaries both in the church and state, was to conciliate her Roman Catholic subjects, who, in rank, wealth, and numbers, far exceeded the Nonconformists. The liturgy of Edward VI., having been submitted to a committee of divines, and certain alterations, betraying a leaning to popery rather than to puritanism, having been made, the Act of Uniformity was passed, which, while it empowered the queen and her commissioners to "ordain and publish such further ceremonies and rites" as might be deemed advisable, forbade, under severe penalties, the performance of divine worship except as prescribed in the Book of Common Prayer. This Act was only partially carried into effect from the time of its being passed, in 1558, to 1565. But in 1565 it began to be rigidly enforced, and many of the Nonconformists were deprived of their preferments (for notwithstanding their sentiments, most of them had still remained in connection with the Established Church, being from principle averse to an entire separation); many also were committed to prison. The High Commission Court, tyrannical in its very constitution, became still more severe in the exercise of its functions; and at length, in 1593, the parliament declared that all persons above sixteen years of age who should absent themselves for one month from the parish church should be banished the kingdom; and if they returned without licence, should be sentenced to death as felons. These provisions, though directed principally against the Catholics, affected the Protestant Nonconformists with equal severity; and with reference both to Catholics and Protestants who dissented from the Church of England, were unjust and impolitic. The Nonconformists, during the age of Elizabeth, are not to be regarded as an unimportant faction. Both among the clergy and the laity they were a numerous body; and they would have been powerful in proportion to their numbers, had they only been more closely united among themselves. A motion, made in 1561, at the first convocation of the clergy which was held in England, to do away with the ceremonies and forms to which the Puritans objected, was lost by a majority of only one, even though the queen and the primate Parker were well known to be opposed to such a change. In the Commons the Puritan influence was strong; and if that house be supposed, in any adequate degree, to have represented the people for whom it legislated, their numerical force throughout the country generally must necessarily have been great. Without presumption therefore they might have expected that their remonstrances would be listened to, and their grievances redressed. And certainly it would have been wiser in the government to have endeavoured to secure their support, than to have awakened their discontent and provoked their opposition; more especially when the hostile aspect of foreign nations is considered, and when we remember that the English Roman Catholics, whose numbers and power rendered them particularly formidable, were eagerly watching every symptom favourable to the re-establishment of the ancient faith. Nor would it have been a difficult matter to yield to the claims of the Nonconformists. The moderate among them sought not the overthrow of the ecclesiastical constitution, but contended merely that certain rites and observances, which they regarded as departures from the purity and simplicity of Christian worship, should be dispensed with; and, generally, that matters commonly recognised as things indifferent should not be insisted on as indispensable. Doubtless many were less reasonable in their demands, and injustice and persecution tended much to increase their number. A party, at the head of which was Professor Cartwright, of Cambridge, desired a change, not only in the forms of worship, but in church polity also, and would have substituted

Presbytery in the room of Episcopacy. Another party, namely, the Independents, or Brownists, as they were then termed, going still further, wished the disseverment of the connection between church and state altogether. Still there is every reason to believe that slight concession to the demands of the less violent, and the display of a spirit of forbearance, would have satisfied many, would have allayed the dissatisfaction of all, and would have been the reverse of disagreeable to the country generally. Unfortunately an opposite course of policy in this and subsequent reigns was chosen; which ultimately conducted to the horrors of a civil war, the subversion of the regal authority, and those disastrous events which make the history of the 17th century one of the most melancholy pages of our national annals.

Queen Elizabeth died in 1603, and was succeeded by James VI. of Scotland. From one who like him had been the member of a Presbyterian church, and had on more than one occasion expressed his decided attachment to its principles and worship, the Nonconformists, not without reason, expected more lenient treatment than they had met with in the preceding reign. But their expectations were bitterly disappointed. In compliance with their petitions, a conference was indeed appointed and held at Hampton Court, at which nine bishops and as many dignitaries were present on the one side, and four Puritan ministers, selected by James, on the other. The king himself presided and took part in the debate. But no good results ensued. The Nonconformist representatives were loaded with insults, and dismissed in such a manner as might well give birth to the darkest anticipations regarding the fate of the party to which they belonged. Shortly after, a few slight alterations of the national rubric were made, and a proclamation issued requiring the strictest conformity. In 1604 the book of canons was passed by a convocation, at which Bishop Bancroft presided. It denounced severe temporal and spiritual penalties against the Puritan divines, and was followed up by unsparing persecutions. In spite however of all the means employed for its eradication, the cause of Nonconformity advanced. In the church itself there were many of the clergy who held the Puritan opinions, though they deemed it inexpedient to make a very open display of them, and who sighed for a change; and the number of such was largely augmented by the alteration which James made in his creed, from Calvinism to the doctrines of Arminius.

The son and successor of James, Charles I., adopted towards the Nonconformists the policy of his predecessors. His haughty temper and despotic disposition speedily involved him in difficulties with his parliament and people. In carrying into execution his designs against Puritanism, he found an able and zealous assistant in Archbishop Laud, under whose arbitrary administration the proceedings of the Star Chamber and High Commission Court were characterised by great severity. Many Puritans sought for safety and quiet in emigration; and the colony of Massachusetts Bay was founded by them in the New World. But a proclamation by the king put a stop to this self-banishment; and thus even the miserable consolation of expatriation was denied. Hundreds of Puritan clergymen were ejected from their cures, on account of their opposition to the Book of Sports, published in the previous reign. Calvinism was denounced by royal authority, and severe restrictions laid on the modes and times of preaching. But a change was approaching. In 1644 Laud was declared guilty of high treason and beheaded; and about five years after, Charles shared the same fate. The parliament abolished Episcopacy and everything in the Church that was opposed to the model of the Genevan church.

During the Protectorate, Presbytery continued to be the established religion. Independency however prevailed in the army, and was in high favour with Cromwell. Under his government the sects of the Quakers and Baptists flourished; and other sects, some of which held the wildest and most visionary tenets, sprung into existence. All were tolerated. Episcopacy only was proscribed; and the Nonconformists, in their hour of prosperity, forgetful of the lessons which adversity should have taught them, directed against its adherents severities similar to those of which they themselves had been the objects. The Restoration in 1660 placed Charles II. on the throne of his ancestors, and led to the restitution of the old system of church government and worship. The Act of Uniformity was passed in 1662, by which all who refused to observe the rites as well as subscribe to the doctrines of the Church of England were excluded from its communion, and in consequence exposed to many disadvantages and to cruel sufferings. During the same reign were passed the Conventicle Act, which subjected all who presumed to worship God otherwise than the law enjoined to fine and imprisonment, and punished the third offence with banishment; the Five-Mile Act, which banished to that distance from every corporate town the Nonconformist clergy, and forbade them to officiate as schoolmasters except on condition of their taking the oath of passive obedience; and the Test Act, which, though directed against the Roman Catholics, pressed with equal severity against Protestant dissenters, and excluded from offices of trust in the state those who refused to receive the eucharist according to the rubric of the Church of England. After this time dissent continued in a very depressed state, and had to struggle with various fortunes, until the reign of William III., when the Toleration Act gave immunity to all Protestant Dissenters, except Socinians, from the penal laws to which they had been subjected by the Stuart dynasty. The benefits conferred by this measure were indeed subsequently much abridged by the Occasional Communion Bill, which excluded from civil offices those Nonconformists who, by communion at the altars of the Church, were by the provisions of the Test Act qualified to hold them; and by the Schism Bill, which restricted the work of education to certificated churchmen. After the accession of George I., however, these laws were repealed, and since then, by the removal of the Test Act, and by the passing of the Acts relating to registration and marriage, dissenters have been allowed the peaceable enjoyment of the rights of conscience, and all the political privileges of their fellow-citizens. It would be a task of some difficulty to enumerate the various sects which may be classed under the general head of Nonconformists. The chief denominations are the Presbyterians, Independents, Baptists, Wesleyan, and Calvinistic Methodists, and Quakers. [Baptists; Methodism; Dissenters; Quakers, &c.]

NONES. [Kalendar.]

NONJURORS. [Theology.]

NONSUIT. If a plaintiff, having commenced a civil action, is guilty of any neglect or default in prosecuting such action according to the practice of the court in which it is brought, he is adjudged *not to follow* or pursue his remedy, and a judgment of *non prosequitur*, or *nonsuit*, is entered, upon which he becomes liable to pay costs to the defendant, and in ancient times a fine to the king for making a false complaint. This is the general meaning of the term; but according to modern practice it has a more limited signification, the phrase non pros (*non prosequitur*) being now used to describe the consequence of most of those defaults on the part of the plaintiff which were formerly comprised under the general term nonsuit. Anciently, when it was the practice for the jury to stand at the bar of the court to hear the evidence on a trial, they withdrew, after the judge had summed up the proofs, to deliberate upon their verdict. On coming back to the bar to deliver their verdict, and before they delivered it, the plaintiff was called in order to be ready to answer the fine which became due to the king for his false complaint, in case the decision was against him; and if, upon this call, he did not appear, no verdict could be given upon the evidence either for the plaintiff or the defendant, and the former was said to be nonsuited. Hence arose a practice that when the plaintiff perceived that the evidence given was insufficient to support his action, and that the verdict would probably be against him, he voluntarily withdrew himself, and did not appear when called; the consequence of which was a nonsuit, which was less disadvantageous to him than a verdict for the defendant, as it did not preclude him from bringing a new action. This practice led to a further innovation upon the ancient proceeding, and it has long been the usual course for the judge to order the plaintiff to be called, or, in other words, to direct a nonsuit, if, upon the whole of the case in support of the action, he is of opinion that there is no evidence upon which the jury would be justified in finding a verdict for the plaintiff. In consonance to the ancient practice, however, by which the plaintiff might in all cases appear when called to answer for his fine, and so prevent a nonsuit, he cannot, except in the County Court, be *compelled* to be nonsuited; and therefore he may insist upon the evidence being left to the jury. It is to this practice of calling the plaintiff, when his evidence, as delivered in court, is insufficient to support his action, that the term nonsuit is now restricted. The consequences of a nonsuit are, that the jury are discharged from finding a verdict, and the plaintiff pays the costs of the suit; but he is still at liberty to commence a new action against the defendant upon the same matter, if he should afterwards be provided with more complete evidence. In the County Court the judge is expressly authorised by statute, if not satisfied with the plaintiff's case, to enter a nonsuit.

NONYLENE ($C_{18}H_{18}$), *Elaene*. A hydrocarbon belonging to the family of biatomic radicals, produced by the destructive distillation of hydroleic and metoleic acids. It is a colourless liquid of a penetrating odour, insoluble in water, but soluble in alcohol and ether. It boils at about 230° Fahr., and is lighter than water. Concentrated sulphuric acid is said to have no action upon it.

NORDHAUSEN SULPHURIC ACID. [Sulphur: *Sulphuric Acid*.]

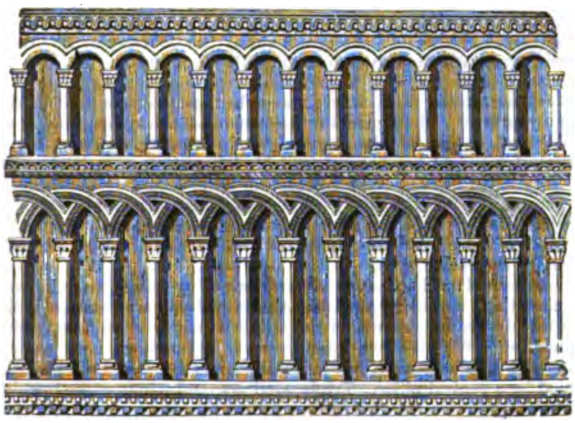
NORIUM (No), a metal said to be contained in the Zircons of Norway and Sweden. Its existence cannot be said to be clearly established.

NORMA, the Rule, a constellation of Lacaille, situated between Scorpio and Lupus. It contains no stars of conspicuous magnitude.

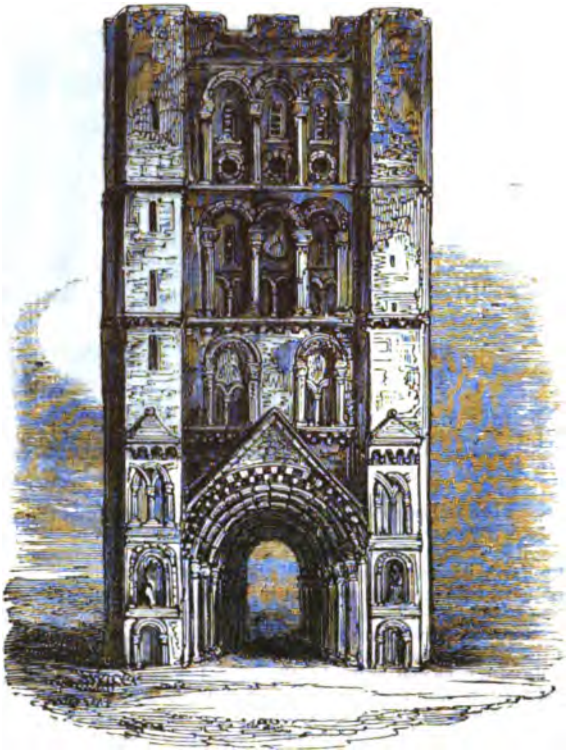
NORMAL. This word (from *norma*) is generally used to mean a perpendicular drawn to the tangent line of a curve or the tangent plane of a surface. It formerly meant simply *perpendicular*. [Tangent.]

NORMAN ARCHITECTURE. In the article Gothic Architecture, that form of Round-arched Gothic known as Norman or Anglo-Norman is spoken of as one of the local modifications of that generic style which, springing from the debased Roman architecture, has received the name of Romanesque. Under the heading Romanesque Architecture, the general characteristics of the style will be described. Here we shall speak only of the variety which prevailed in this country from the middle of the 11th till near the close of the 12th century, or from the date of the Conquest to the close of the reign of Henry II., 1189. It was preceded by the Anglo-Saxon, a style which differs from it in no essential particular, being in fact little more than a rude imitation of the architecture practised on that part of the Continent with which the Anglo-Saxon princes and priests were in most intimate communication: and the more important buildings at least were probably executed under the direction or with the assistance of Norman architects. But as this style has received a specific name, and is usually treated as a distinct style, it will be more convenient to defer our notice of it to a separate heading. [Saxon Architecture.] At the same time, as we said of the various styles of Pointed Gothic, it is important to bear in mind that none of the styles of English architecture are separated by sharply defined dividing lines. As each style of Pointed Gothic grew out of a preceding style, and became gradually absorbed in its successor, so did the Round-arched Anglo-Norman gradually emerge from the rude Anglo-Saxon, and, after a vigorous independent existence of a century's duration, quietly and by degrees make way for or become developed into the Early English, or First Pointed Gothic.

In considering Anglo-Norman architecture, it should be remembered that there are few buildings remaining which are in this style throughout, though there are many which retain detached parts and features belonging to and some which mainly consist of it, more or less intermixed however with what is of later date and different in style. A great deal of Norman work is to be met with in the older parts of several of our cathedrals, and also in many smaller churches, such as Barfreston in Kent; New Shoreham, Sussex; Iffley, Oxfordshire; Steetly, Derbyshire, &c., which, having remained comparatively untouched, exhibit, although upon a limited scale, more of the Norman style and the peculiar mode of applying it than many larger edifices, notwithstanding that these latter occasionally present decorative features in this style which do not occur in buildings of a less pretending character. The older parts of Canterbury, Durham, Winchester, Gloucester, Peterborough, Ely, Norwich, Lincoln, and Oxford cathedrals are in this style. The nave and choir of Norwich in particular (founded in 1096), with the exception of pointed windows of later English character inserted in the upper part of the choir, are almost entirely Norman, of which they present a very fine example. Very little, however, remains to show the style of exterior composition employed by our Anglo-Norman architects in their larger edifices. The west fronts of Rochester and Lincoln cathedrals are almost the only parts that can be considered as specimens of Anglo-Norman architecture; yet each of them has many interpolations of other styles. The lower part of the former is entirely Norman, and has a remarkably fine though not very spacious centre doorway; but the large window over that entrance, in the Third Pointed or Perpendicular style, is so very prominent a feature, as greatly to take away from the effect that would else be produced by the other parts. The front of Lincoln presents little more than a surface decorated by tiers of small columns and arches of the kind known as arcades [Arcades], which form so characteristic a feature of Norman architecture. These arcades are frequently carried in several tiers over each other to a considerable height, as in the tower at St. Edmunds, Bury, and the S.W. wing of Ely cathedral. Considerable variety is given to them by occasionally doubling the columns and varying the capitals, and still more by causing the arches to intersect, thereby bringing into strong relief the form of the pointed arch; though it is quite certain that this intersection did not, as some writers have suggested, give rise to the pointed arch, since it was in existence long before. [Arch.] Wherever a superior degree of decoration was aimed at, the Anglo-Norman builders seem to have contented themselves with covering what would else have been blank surfaces with these tiers of columns and arches. The two transept towers of Exeter Cathedral, the front of Castle-Acre Priory, and of St. Botolph's Priory, Colchester, present little more; consequently, notwithstanding the variety as to detail, there is a very great sameness as to general composition and design.


Arcades from the front of Lincoln Cathedral.

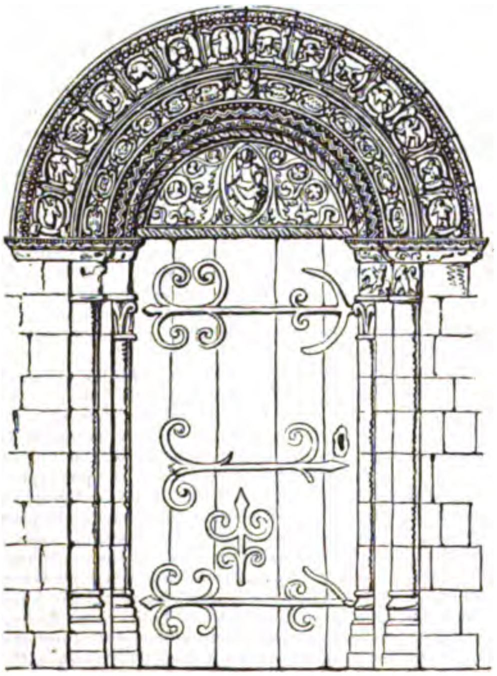
In the interior of buildings this style exhibits itself more decidedly, owing not only to the perspective effect of a succession of spacious open arches, as in the Naves of Norwich, Durham, Rochester, Chichester, Ely, and Peterborough cathedrals, but also to greater size and massiveness. Although such difference of character may at first appear somewhat incongruous, it being usual to find more minute and delicate forms employed for the internal parts of a building, the reason for it is evident; the tiers of pillars and arches on the exterior of Norman structures are merely decorations of the surface, while the arches and piers within are essential parts of the fabric. Instead of anything like lightness, we here meet with extraordinary massiveness arising from the immense bulk of the piers from which arches spring: which character exhibits itself most strikingly when, as is the case with some of those in the nave of Norwich cathedral, the piers are merely short cylinders, with a kind of plain capital, and are not formed by shafts attached to a central mass of masonry. In the building just mentioned some piers of that description are ornamented on their surface by spiral grooves or flutings; and we may here remark that in that and other examples both cylindrical and clustered piers occur, not only in the same building, but in the very same part of it; and that great variety of detail and ornament is frequently observed in the mouldings of arches, columns or piers and their capitals, though they are uniform as to size, and compose a single range. Owing to the great diameter required for the supports of larger arches below, the mere pillar-shape was never employed for them, for although pillars of slender proportions were introduced for such purpose, it was only as *pier shafts*, or when the entire pier was made to consist apparently of a cluster of slender pillars, as some of those in the nave at Durham. Slender detached pillars are indeed of not infrequent occurrence, but it is only to support small arches, as where a window is divided into or composed of two or more such arches, or in the triforia and other galleries within the building, where openings corresponding with the larger arches below are divided after the same fashion, and therefore do not form a continued arcade, but coupled or tripled arches at intervals, between the main piers. Sometimes the larger arches below, instead of being connected and resting upon the general capital of the pier, spring from *nook-shafts* or slender attached pillars, within the re-entering angles of the pier itself, the face of which was either left as a plain space dividing those pillars and the arches from the adjoining ones, or else decorated with another shaft carried quite up to the springing of the vaults, and therefore very appropriately distinguished by Whewell by the term *vaulting-shafts*. The nave of Chichester, and the Abbaye aux Hommes at Caen, give a combination of both these modes. But although attached pillars and shafts were almost uniformly of exceedingly tall and slender proportions, we occasionally meet with pillars short and stumpy and with bulky capitals, although the arches are very narrow, and the pillars themselves in situations where more delicate forms would have been sufficient. Of single columns approaching to the proportions of ancient Roman columns, like those which are found in the Romanesque buildings of Italy, Anglo-Norman structures afford no true examples. The only instances are in Semi-


Tower of Bury St. Edmunds.

Norman or Transition buildings, like that part of Canterbury cathedral called Becket's Crown, (see the cut, col. 973), where columns partaking very much of the Corinthian character, though somewhat bolder and more masculine, are employed as piers to support the arches (not round-head, but pointed); or they are rather coupled columns united back to back. Within crypts very short detached single columns were employed to support the arches of the vaulting, but this deviation from the usual practice would seem to have been occasioned merely by the local peculiarities of such subterraneous apartments, and consequently it can hardly be considered as characteristic of the style itself.

Interior of Durham Cathedral.

The plan and general arrangement of a Norman church are the same as have been followed in subsequent styles. [Church.] The larger Norman churches are cruciform with a low massive tower rising from the intersection of the arms of the cross. Smaller churches consist only of a nave and chancel. Choirs and chancels were frequently apsidal, as were also the chapels attached to the larger churches, but many of these apses have been removed. [Apse.] Norwich cathedral affords a good example of the Anglo-Norman apse. Sometimes in these apses the high altar was attached to a reredos, which was fixed between the piers, and a space left behind for the passage of processions which could thus on solemn occasions make the entire circuit of the church. Numerous examples however occur in which the chancels are rectangular in plan. The aisles were often extremely narrow, and some small churches occur without aisles. Choirs were usually vaulted, but no example we believe occurs of a vaulted nave. *Crypts*, some of them of fine proportions, considerably enriched, and excellent specimens of masonry, are common under cathedrals and large churches: the crypt of Canterbury Cathedral is one of the finest. [Crypt.]

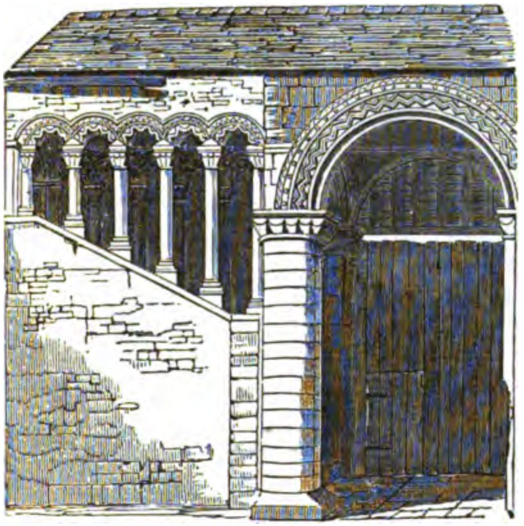

Doorway, Barfreston.

Having spoken of the style generally, we shall now briefly describe its principal component parts and separate features; but though not numerous in themselves, it would occupy some space and require a great number of explanatory cuts, to attempt to notice them with much particularity, for few as are the general forms, and unvaried as is the general character, the diversity of detail and minutiæ is exceedingly great.

Doorways, even in small and otherwise plain Norman buildings, and even when small in themselves, seem almost always to have had a great deal of embellishment bestowed upon them; and many have therefore been preserved in buildings, in every other part of which nearly all traces of the original edifices have been obliterated by subsequent alterations: instances occur, however, where the doorways have merely a plain dripstone moulding above the arch. In many instances doorways are very deeply recessed, and in proportion to the aperture or door itself the dressings or decorations occupy a great space: this not only allowed great latitude in other respects, but enabled the architect to make what would else have been an insignificant feature, an important one in the design. In some cases, as at Malmesbury Abbey church, there are no fewer than eight concentric arches recessed one within the other. The tympanum, or stone which in many examples fills the semicircular head of the arch, is usually covered with sculpture. We give a cut of the doorway of Barfreston church, Kent, which, although small, will illustrate the richness and elegance of character of a Norman doorway, and serve as an example of a square-headed door, where the arched space above it is filled up with sculptures. The figure in the centre of the tympanum, it will be observed, is that of the Saviour, who is seated within an aureole [Nimbus], his right hand raised, and his left resting on a book. This is a very usual decoration on Norman doorways, and is in allusion to the passage "I am the door," &c.; but other scriptural, legendary, or symbolical figures are also frequently represented. Symbolical sculpture is indeed very largely introduced in every part of a Norman church of the better class.

Windows had seldom much decoration; they were generally small and placed at a considerable distance from each other; sometimes they were merely plain apertures in the wall, and rarely more than scantily ornamented. We give two specimens of Norman windows, one consisting of a single opening, but more than usually enriched, the other divided by a central pillar. Triple windows, and window-like openings in internal galleries, divided by two pillars into three arches, of which the middle one is wider and loftier than the others, also occur. There are also windows in this style which, though narrow, are of very considerable dimensions as to height, like those at the east end of Canterbury Cathedral. In regard to this feature, the Norman and Pointed Gothic styles differ essentially, as much, if not more, than they do in the mere form of their respective arches: for besides that windows are very secondary features in the one style, whereas they are among the principal and most characteristic features in the other, Norman windows have neither mullions nor transoms, nor any tracery or open compartments in the head of the arch; for even where the aperture is divided into two smaller arches, resting upon a central pillar, the space or head between those arches and the larger one which includes them is never perforated or otherwise decorated. Hence the windows themselves were necessarily limited as to size: not but that it would have been very possible to increase the number of openings by means of additional pillars, and by afterwards perforating the general head of the window above the smaller arched divisions, although not with equal consistency as in Pointed Gothic, where the mouldings of the mullions are continued upwards and form the ribs of the tracery, however complicate it may be. Sufficient hints for such purpose might have been found in some of the intersecting patterns of ornament which occur among the exterior enrichments of Norman buildings. As a very peculiar and interesting specimen of Anglo-Norman architecture, and for the purpose of showing how, by increasing the number of openings and pillars, windows might have been extended in this style, we here exhibit a sketch of an external staircase leading to the registry at Canterbury.

Window, Caston Church,
Northamptonshire.

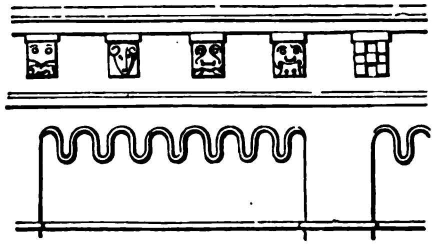


In this example there is somewhat to remind us of the open galleries of the Italian Lombardic, especially of those upon sloping lines beneath pediments, with this difference, that here the arches form a horizontal line. We have here also an instance of what was by no means uncommon in small arches in this style when they are not pierced through, which is, that the inner margin of the arches is formed by a chevron moulding which scallops them.

Pier-Arches, that is, open arches resting upon piers, as those within churches, do not materially differ in design from those which ornament doorways, except that they are not so profusely decorated, and the archivolt mouldings do not occupy by any means so much space in proportion to the width of the opening. The arches themselves being uniformly circular (though in some few cases either somewhat more than a semicircle or prolonged perpendicularly to the impost), exhibit so far no variety; still as regards the entire aperture, of which the arch itself forms the head, there is very great variety of character, according to the proportion which the heights of the supporting piers bear to the diameter of the arch, or opening between them. About twice the breadth appears to have been the average height of arches (namely, openings) between piers; when much above that standard they may be called lofty (as the arches of the nave at Durham); and when much beneath it, they may be considered of low proportions. Besides the difference of character thus occasioned, much is also produced both by the form and proportions of the piers themselves. A circular or octagonal pier, for instance, appears much more massive than one composed of clustered shafts, &c., though the general diameter of the latter may be the same, or even somewhat more. Though we cannot pursue this point any further, we would recommend those who feel at all interested in the subject to make such comparisons for themselves; and they will doubtless find that they will be led on to make many others, and to enter into original investigations.

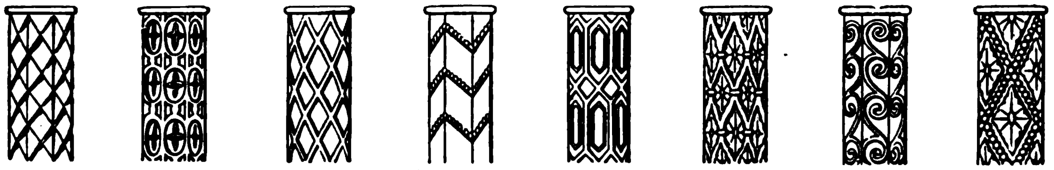
Vaulting is an important and characteristic feature in Norman architecture. In early buildings plain semi-cylindrical, or as it is termed barrel or waggon vaulting occurs, as in the White Chapel of the Tower of London. More common is the quadripartite or Roman vaulting, as in the Crypt of Canterbury Cathedral. Groined vaulting is usual in later examples. The crypt at Westminster Abbey, and the cathedrals of Winchester, Worcester, and Gloucester, afford characteristic specimens of Norman vaulting. Vaulted ceilings occur in Norwich, Durham, Peterborough, and the choir of Canterbury cathedrals. Over the vaulting of the aisles was in the large churches a Triforium. [Triforium.]

Buttresses, to which buildings in Pointed Gothic are indebted for so much of their character and effect, can hardly be said to exist in Norman architecture. The enormous thickness of the walls and their solidity, owing to the smallness and infrequency of apertures in them, rendered such additional support unnecessary, even when the vaulting of the roof was large and bold. Hence nothing more than either *buttress*, or *pilaster strips* (as they are conveniently termed by Mr. Whewell), were introduced, and these more for the sake of producing some variety and degree of expression than for actual strength, their projection beyond the general plane of the wall being very inconsiderable, and no more in fact than that of the corbelled parapet, or *corbel-table;* consequently buttress-strips do not so properly constitute projecting surfaces, as the intermediate spaces of wall form recessed compartments, or large pannels. The parapet itself was seldom more than a plain corbel-table, without battlement; but sometimes, instead of forming a horizontal line, the lower edge of the corbel was what might be described as *embattled-reversed*, that is, indented like a range of battlements hanging downward, or else made *wavy*, or scalloped with curves.

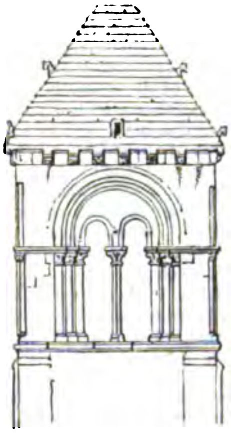


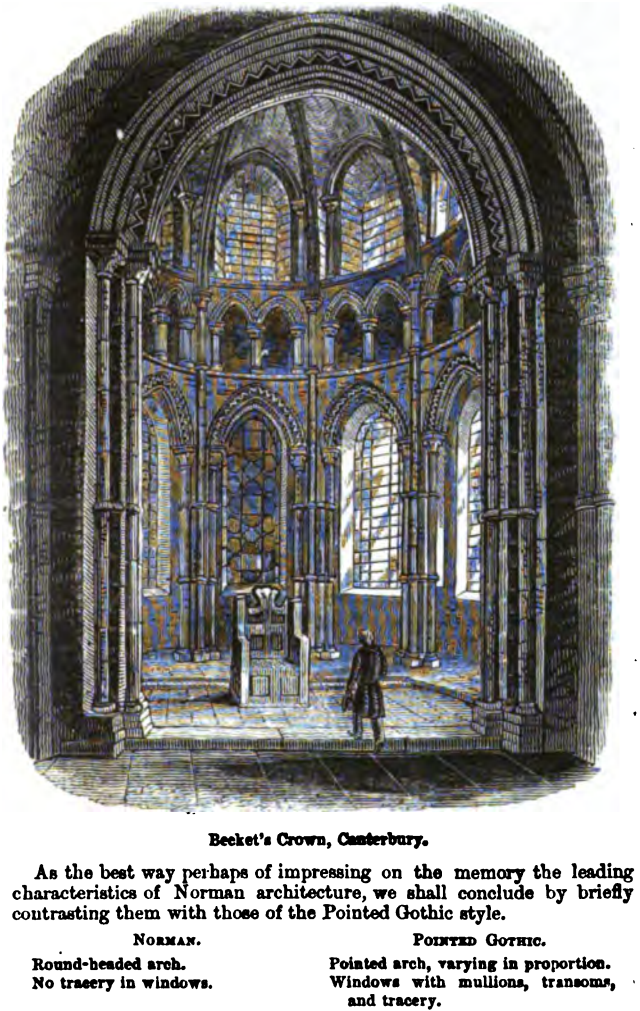
But the more common mode was to make the lower edge of the corbel table straight, with a series of corbel mouldings beneath it frequently intersected by small blocks at intervals (after the manner of modillions), which were either left plain or sculptured with grotesque heads and figures. Occasionally again the corbelling assumed the form of a series of small interlacing arches.

Pillars and *Columns*, with which the massive circular arch-piers, or piers with nook-shafts, are not to be confounded, exhibit great diversity of character, both as to proportions and decoration, from the rudest and plainest forms to either the lightest or the most enriched. Neither are the two terms precisely synonymous, it being as well to observe the distinction made between them by Whewell, and to restrict the latter term to such pillars as approach to the general proportions and character of classic columns. *Pillars*, on the contrary, have very great variety of proportions, either much below or greatly above such standard, being generally adapted to the load they have to sustain, without any regard to classic or any other metrical proportional. The shafts are for the most part plain, though instances occur of their being carved (as was oftener than not the case with the columns of Lombardic porches); and in the undercroft at Canterbury Cathedral there are pillars whose shafts are fluted spirally. Raised mouldings, intersecting each other spirally so as to form a diamond-pattern on the surface, are by no means unfrequent; and some of the circular arch-piers in Durham cathedral are so ornamented: zigzag or chevron lines were also employed for decorating the surfaces of piers and columns, and were disposed either annularly, in horizontal rings, or spirally. Of these and some other varieties specimens are here shown.



unnecessary to dwell on a style that is essentially without individuality; its character being a compound of the styles between which it stands. A good example of this style is that portion of Canterbury Cathedral called Becket's Crown, erected in 1184.





Becket's Crown, Canterbury.

As the best way perhaps of impressing on the memory the leading characteristics of Norman architecture, we shall conclude by briefly contrasting them with those of the Pointed Gothic style.

Norman.	Pointed Gothic.
Round-headed arch.	Pointed arch, varying in proportion.
No tracery in windows.	Windows with mullions, transoms, and tracery.
Buttress-strips.	Buttresses rising in offsets or stages.
No pinnacles, properly so called.	Pinnacles.
No battlements, except in castles.	Battlements in the ecclesiastical as well as military style.
Spires scarcely known.	Spires characteristic features.
Splayed surfaces of rare occurrence.	Splays for receding parts, universal.
Niches infrequent.	Niches very general.
Windows generally small and few.	Windows spacious and numerous.
Horizontal lines and arrangements prevalent.	Vertical lines and arrangements.
Arch-piers very massive.	Arch-piers comparatively slender.
Vaulting simple and mostly plain.	Vaulting more complex and decorated.

NORMANDY, CUSTOMARY LAW OF. Previous to the first Revolution the several provinces into which France was divided were chiefly governed by a system of laws which, arising originally from local usages, became in after time embodied in a code which obtained the sanction of the sovereign, and became the established law of the province. These codes were styled customs, *coutumes*, and have been largely and learnedly commented upon by various jurists of the period, whose commentaries were often received as law. The customary of Normandy ranks among the most ancient of these customaries. According to it, laws, customs, and usages, were regulations of a very different authority: the laws were enacted by the sovereign, reduced to writing, and registered by the exchequer, afterwards denominated the parliament of Rouen; customs originated with the people, and in time were compiled and reduced to writing by the supreme authority. Hence the difference between *loi*, *us*, and *coutume*, as understood in the ancient provinces of France. By *loi* was understood the royal ordinances and Roman law; by *coutumes*, or customs, those regulations which had been compiled and received the sanction of the sovereign; by *us* or usage, such regulations as had not been reduced to writing. Normandy, both as an independent state, and after its annexation to the crown of France, may be said to have had three distinct codes; *le grand coutumier*, or ancient customary; *la charte aux Normands*, or Norman charter; and the modern custom. The ancient and modern custom related more particularly to property, &c; *la charte aux Normands* to the political liberty of the subject. The Norman charter was granted by Louis X., its principal object being to restrain the kings of France from imposing too heavy burdens on their Norman subjects. This charter was confirmed six times from its promulgation to the reformation of the customary by Henry III., which affords a fair presumption that it had been often violated. The customs of Normandy were first reduced into writing by a private hand in the reign of Louis IX., about the year 1229, which corresponds with 14 Henry III. of England. Being subjected to examination under Charles IX., many of its reforms were sanctioned by the high authority of the Chancelier l'Hôpital, and the modern reform dates from 1585, under Henry III. This custom was known throughout France by the appellation of *la sage coutume*. The number of provincial customs of France before the Revolution were reckoned at eighty, and its local usages at nearly three hundred. In Normandy there were no less than twenty-two different modes of devising patrimonial estates, corresponding to the number of vicomtés or districts of which the province was composed.

L'Ancien Coutumier is divided into 125 chapters, nearly two-thirds of which are devoted to regulate the duties of the judicial officers, the proceedings in the different courts, and the respective rights and obligations of the kings of France, the dukes of Normandy, the feudal lords and people. The transmission of property by wills and inheritance, which occupies so large a portion of modern law and of the reformed Norman law in the 16th century forms a very small portion of the *Ancien Coutumier*.

The modern or reformed *Coutumier de Normandie* is divided into 24 chapters, which are subdivided into 622 articles. The modern *Coutume* was reformed at Rouen on 1st July, 1585, by commissioners appointed by Henry III. of France with the concurrence of the provincial authorities known as *les gens des trois états*, or three orders representing the nobility, clergy, and people.

Among the peculiar customs of Normandy was *la clameur de Haro*, which custom still prevails in the Channel Islands, where the Norman ancient customary is the principal law; and may be denominated a call upon the supreme authority for justice, "appellatio ad principem ad opem in lite ferendam." The term is considered to be derived from Duke Rollo, or as the name is variously spelt, Raoul, Roul, and Rou (Du Moulin's 'Hist. de Normandie,' lib. i. c. 9, and lib. vii. c. 20), "Haro" being a corruption of the cry Ha!, or Ha Rou, by which this prince, who was remarkable for his justice, is said to have been invoked. It is thus practised in the Channel Islands. When an individual considers that another is infringing upon his right of property, he, in the presence of two witnesses, protests against the proceedings, and, crying out three times "Haro," summons the trespasser to desist. He then applies to the judicial authorities, declaring what he has done, and proceeds to the register, or record office, where note is taken of the particular circumstances of the case; he afterwards brings an action against the trespasser. If he neglect to do so, then the person against whom the "Haro" was cried may bring his action against him who cried it, and oblige him, if he cannot justify his proceedings, to desist and submit to the judgment of the court. Upon the action of either of the parties the decision is generally referred to what is termed *une vue de justice*, or an examination by the court of all the circumstances on the spot itself. The party condemned is subjected to a small fine and pays all costs; in addition to which he was formerly punished by what was termed *un regard de château*, that is, twenty-four hours' imprisonment; the imploring the aid of the prince without cause and the invasion of another's possession being accounted equally criminal. In ancient Normandy parties resorted to the *clameur de Haro*, in cases of assault and battery, but that part of the custom has never prevailed in the Channel Islands.

The president or chief judicial officer in Guernsey is still styled bailiff, the name by which he is designated in the ancient *Coutumier de Normandie*. In Jersey he is styled bailly, by which name he is designated in the modern customary of the same island. In Alderney this officer is styled juge. In each island he is appointed by the crown; and his authority continues much the same as laid down in the ancient *Coutumier*. It is his duty to maintain order, to decide according to law and usage all disputes arising between parties residing within his jurisdiction; and to put down all thieves, incendiaries, and other malefactors.

The first commentary on the Grand Coutumier of Normandy was written by Rouillé, a jurist of Alençon (Guillaume de Rouillé, 'Commentaire sur la Coutume de Normandie,' fol., 1534, reprinted in 1539). It was followed by that of Terrien of Dieppe, which was published in 1574, after his death (Guillaume Terrien, 'Commentaire sur les Coutumes anciennes de Normandie,' fol.). After the revision of the customary in 1585, several modern commentaries appeared. The best editions are 'Décisions sur chaque article de la Coutume de Normandie,' &c., par Pierre de Merville, Paris, 1731, fol.; Bérault, Josias, born 1563, died 1640, 'Commentaire sur la Coutume de Normandie,' Rouen, 1684, in fol.; Basnage, Henri, born 1615, died 1695, 'Commentaire sur la Coutume de Normandie,' Rouen, 1678–1681; Godefroy, Jacques, 'Coutume du Pays et Duché de Normandie avec les Commentaires de Bérault, Godefroy et d'Aviron,' Rouen, 1684, 2 vols. fol.; Flaust, Jean Baptiste, born 1711, died 1783, 'Explication de la Jurisprudence et de la Coutume de Normandie,' 2 vols. fol.; Pesnelle, 'Coutume de Normandie avec la observations de Roupnel,' Rouen, 1759, in 4to; Houard, David, born 1725, died 1803, 'Traité sur les Coutumes Anglo-Normandes,' Rouen, 1776, 4 vols. 4to.

Hale, in his 'History of the Common Law of England' (chap. vi.), maintains that the 'Coutumier of Normandy' was written long after Glanville's tract, which was written in Henry the Second's time; and that the Norman collection was made after the time of Henry II. appears from its mentioning his coronation, and appointing it for the limitation of actions ancestral, which must at least have been thirty years after. "Nay, the 'Coutumier' appears to have been made after the act of settlement of Normandy in the crown of France, for therein is specified the institution of Philip, king of France, for appointing the coronation of king Richard I. for the limitation of actions, which was after the said Philip's full possession of Normandy." Hale's opinion is, that "this similitude of the laws of England and Normandy was not by conformation of the laws of England to those of Normandy, but by conformation of the laws of Normandy to England."

NORROY. [Heraldry.

NORTH AMERICAN INDIANS. The name of Indians was applied to the indigenous inhabitants of America on the first discovery of that continent, on the supposition that it formed a part of Asia, and the name has been retained ever since. By the great majority of those of South America considerable progress in civilisation had been made at the time of the discovery, as is proved by our knowledge of the kingdoms of Peru, Quito, and, farther north, Mexico, and vestiges of this civilisation have been even preserved. A further portion was reduced to a state of semi-civilisation by the exertions of the Roman Catholic missionaries, and their influence is still visible in Paraguay and other places. Still there are a few tribes, as the Abipones in Paraguay [Abiponians, in Geog. Div.], the Guarinis in Brazil, and a few others, which maintain a species of independence by living apart from the more civilised portion. But in North America, though pressed on all sides by the rapid increase of the immigrant European population, dispossessed of the most fertile parts of their territories, and vastly reduced in numbers by successive wars and the introduction of European diseases and vices, they have, with few exceptions, refused to amalgamate, or accept the opportunities of improving their position, but maintain their savage tastes, manners, and customs, with a precarious independence, depending on their withdrawal to still wilder regions as civilised man advances on their position. Their numbers now are not estimated at more than 1,500,000 in the whole; they are scattered over a vast region, and they consist of a great variety of nations, as they term themselves, from the fact of their speaking a variety of languages, said to be full 500 in number, though certainly many roots are common to most of them.

George Catlin, in his 'Letters and Notes on the Manners, Customs, and Condition of the North American Indians,' London, 1841, says that there is no idolatry found amongst them; all worship or acknowledge one Great Spirit, and know nothing of any intermediator. The Mandans he thinks the relics of the mythic Welsh expedition of Madoc. They have little government, though each tribe has a chief. The chief, however, has little real authority, and is in fact only a leader in war. They have no established laws beyond the few penalties established by custom, and their punishments when inflicted are cruel. War is decided on by the chiefs in council; the chief's pipe, coloured red, is sent through the country by messengers, and every volunteer draws the smoke once through its stem, and thus pledges himself to serve: but he is still a volunteer, and is only restrained by pride, or the shame of retreat, or by feeling an immediate interest in the contest, from quitting the chief whenever he chooses. He adds that little progress has been made in mechanical arts, and the figures cut on rocks or in turf show but little skill in design.

The physical character and appearance of these natives has been given in the Man of America, in the Geog. Div., col. 294; but we may add that on the whole they do not exceed the average stature of Europeans, but in some tribes the men exceed six feet in height; that they are more formed for fleetness than for strength; that they have the virtues and vices of most savage tribes, hospitality and protection to strangers who trust them, revenge against enemies, want of prudence, and intemperance. Names are given to about 120 tribes or nations, most of them speaking a language different from the rest, though some of them now number but a few scores, and many but a few hundreds. We shall only notice a few of the more important of these tribes, taking them alphabetically, in accordance with our general arrangement.

Algonquins. [Algonquins, in Geog. Div.]

Arapahas, a small tribe of about 4000 souls, inhabiting the plains of the river Platte, at enmity with the Crows.

Araphoes are neighbours of the Camanches, inhabiting the Rocky mountains, with Santa Fé on the south and the coast of California on the west. They, with the Navahoes, who inhabit nearly the same districts, have much harassed the American settlers in California.

Aricaras, or *Rikarees*, dwell on the plains of the Upper Missouri, between 46° and 47° N. lat. They are skilful horsemen, were allied with the Mandans and Minatarees, and hostile to the Sioux, which are the neighbouring tribes. Their habitations are formed, in a conical shape, of wooden frames interlaced with osiers; and they amount to about 3000.

Assinaboins, or stone-boilers, so called because they cook their food by inserting hot stones successively in a pit filled with water till the water boils. They inhabit the plains along the base of the Rocky Mountains, around the upper part of the Missouri, at its junction with the Yellow-sand river. Their number is supposed not to exceed 7000. They are horsemen, and use the gun with effect; they are a branch of the Sioux, and are usually allied with the Crees and the Ojibbeways, and at variance with the Blackfeet.

The *Beaver* Indians, of whom little is known, dwell about the forks of the Mackenzie river, west of Bear Lake. Their district is a wide one. With the *Hare* Indians and *Loucheux*, who extend along the same river to the north, it reaches from about 61° to 70° N. lat., where they are bounded by the Esquimaux. Their numbers are unknown.

The *Blackfeet* is one of the most powerful tribes of the Rocky mountains; it includes several minor tribes, as the Blood Indians, the Surcees, Grosventres, Cotonnois, &c., and their numbers are estimated at 20,000. Wilks ('Narrative of the United States Exploring Expedition, 1838 to 1842') thinks the number exaggerated; but Catlin, who was among them, estimates the number, including all the sub-tribes (which, however, he thinks are improperly classed as Blackfeet), at 23,000. The Blackfeet proper inhabit the district around the sources of the Missouri, but the Blood Indians extend to the roots of the Rocky Mountains on the west. The Blackfeet are of middle stature and robust make; are good horsemen, brave, and almost continually at war with one or other of the surrounding tribes.

Bonacks, or *Bannacks*, are widely scattered around the Snake river, and are neighbours and foes of the Blackfeet. Their numbers are small, but they are brave and enterprising, and accustomed to the use of fire-arms.

Camanchees, with the *Pawnee Picts* and a few minor tribes, such as the Kioways and Wicos, occupy a great portion of Texas about the Washita river, and the head waters Rio del Norte and the Arkansas river, the Pawnees extending to northern California. They amount together to about 19,000 souls, have large numbers of horses, are daring and expert riders, but, unlike most of the tribes, are not active on their feet. The women cultivate maize and a few other vegetables; the men are all warriors, and have maintained many contests with the American settlers. The Kioways are said to be a handsomer race than the Camanchees, and to speak a different language, but they are closely allied in manners.

Cherokees. [Cherokees, in Geog. Div.]

Chinooks is apparently a general name for a number of tribes that inhabit British Columbia, in the neighbourhood of the Oregon. They are short, bow-legged, with wedge-like heads, produced by compressing the skulls of ther infants, high cheek-bones, long hair, aquiline noses, and of a light copper-colour. They live chiefly on fish. The *Chillcoatans* are found about Fraser's river. Other sub-tribes are the Callapayas, Cathlamahs, Clatsops, Klackatacks, Wahkiacums, and Wallawallas, the whole amounting to between 3000 and 4000. They live principally by fishing, the salmon caught in the Columbia river forming the chief part of their food. This they prepare by pounding the salmon, pressing the flesh between mats, and drying it, in which state it will keep good for three or four years.

The *Chicksaws* and *Choctaws* were located in Mississippi, and numbered about 10,000 souls, but they have been transferred by the United States government to the district west of the Mississippi, where they now remain, reduced in number.

Cheyennes number about 2000; they are a branch of the Shaways, and were originally located in Wisconsin, whence they were driven by the Sioux, and now dwell about the Cheyenne river, towards the sources of the Upper Missouri. They are a tall and handsome race, possess many horses, and the women raise some corn and other vegetables.

Crees and *Chippeways* constitute at present one of the most numerous and most widely extended of the aboriginal nations which inhabit the interior of North America, amounting to upwards of 10,000. The Crees, formerly called by the French Knistineaux, inhabit the shores of Hudson's Bay from Moose river, which falls into the south-western corner of James Bay, to the mouth of Churchill river (about 59° N. lat.), and hence they extend westward to the Athabasca lake, and to the plains which lie betwixt the forks of the Saskatchewan, near Carlton House. They do not extend to the Rocky Mountains, the plains lying along the base of this range being in possession of a branch of the Assineboin Indians, who are of the Sioux stock, and speak the language of the Iroquois or Hurons. The Chippeways inhabit the country about Lakes Michigan, Huron, and Superior. But it seems that many other tribes belong to the same stock as the Crees; for all the nations which are within the limits of the United States north of the Ohio and east of the Mississippi speak languages which may be considered only as dialects of that spoken by the Crees and Chippeways. [ALGONQUINS, in GEOG. DIV.] (See 'Sir G. Simpson and North American Indians,' Kane.) The *Lennapi*, one of these tribes, have a tradition amongst them, that "their ancestors, coming from the westward, took possession of the whole country from the Missouri to the Atlantic, after driving away or destroying the original inhabitants of the land, whom they termed Alligewi. In this migration and contest, which endured for a series of years, the Mengwe or Iroquois kept pace with them, moving in a parallel but more northern line, and finally settling on the banks of the St. Lawrence and the great lakes from whence it flows." (Richardson in 'Franklin's First Journey.') The Crees, like the other tribes of North America, live upon the produce of the chase and the fisheries in the numerous lakes and rivers by which their country is watered. No kind of agriculture has been introduced among them, as among those tribes that inhabit the southern portions of the United States. This is chiefly to be ascribed to the general sterility of the countries which they inhabit, and partly to the rigour of the climate. Even in the European settlements no attempt to sow and plant has been made north of Carlton House, on the Saskatchewan, and at the latter place only on a small scale. The hardships to which their manner of life frequently exposes them, and the want of food for some weeks together, sometimes compel them to commit cannibalism; and Captain Back relates instances of this, and others of their abandoning the old and infirm. Instances of this kind are on record, even of parents having fed on their own children; but these extreme cases are of rare occurrence. They commonly evince a strong affection for their offspring, and bewail for a length of time the loss of their relations. Europeans are very little acquainted with the language of the Crees. M'Keevor has added a short vocabulary to his voyage. Dr. Richardson collected a copious and valuable vocabulary, which is still unpublished. Mr. J. Howse of Cirencester, who was in the service of the Hudson's Bay Company for twenty years, has prepared under the sanction of the London Geographical Society, a grammar of the Cree language. (Back's 'Narrative of the Arctic Land Expedition,' in 1833, 1834, and 1835.)

Creeks were, at the beginning of the present century, one of the most powerful native tribes within the limits of the United States of America. They occupied nearly all the countries lying north of 31° N. lat., between the Flint river, the eastern branch of the Chatahoochee, and the Tombidgee or western branch of the Mobile river, and numbered nearly 24,000 souls. Their wars with the United States were uniformly unsuccessful, and they have now been, together with the Cherokees and Choctaws, transported to a district west of the Mississippi, a large tract of country having been ceded to them by the United States.

Crows is the name of the tribe inhabiting the country in the recesses of the Rocky Mountains, between the Wind River Mountains and the river Platte, the upper part of the Missouri near its junction with the Yellow-Stone river to the Big-Horn river on the south-east. They number nearly 4000, are noted for their predatory habits, horses being especially the objects of their plunder, to procure which they extend their excursions for long distances on each side of the mountains, and are in constant hostility with all the surrounding tribes.

The *Hurons* between Lakes Huron and Ontario; the once-powerful *Iroquois*, who extended on both sides of the Mississippi; the *Mohicans*, who were at home in Connecticut; the *Oneidas* and *Onondagas*, of New York; the *Shawanoes* of Pennsylvania, to which may be added the *Delawares* from Delaware Bay, are now all but extinct. The last-named two have both possessed Wyoming at different times, and the bones of their ancestors repose on "Susquehanna's banks." Except the Delawares, Shawanoes, and Oneidas, of whom fragments have been located west of the Mississippi, and have become in some degree agriculturists, only individuals remain. The Iroquois language, however, is said to be yet widely spoken.

The *Iaways*, who only number 1100, live between the forks of the Grand River and those of the River des Moines on the west of Illinois. They are probably a branch of the Sioux, whose territory adjoins them.

The *Kickapoos* are a small tribe of about 800, living near the south end of Lake Michigan, in Illinois.

The *Mandans* were one of the most curious tribes. They were located, prior to 1840, on the west bank of the Missouri, 1800 miles above St. Louis, and 200 below the mouth of the Yellow Stone. Number, about 2000. They did not bury, but placed their dead on scaffolds, there to moulder and decay. When the scaffolds fell, and the flesh had decayed, the skulls were placed on the ground in circles, and the other bones were buried. The colour of the hair and complexion was various: the hair of females in youth being often of a silvery gray, fine, and silky. They swam not like Europeans, but, throwing the body on one side, the hand was drawn through the water inward under that side, while the other hand reached as far forward as possible. out of the water, till the lower stroke was completed; then the side was changed, and the other hand was drawn through the water. They were polygamists; as the wars carried off so many men, there were often three females to one male in a tribe. They raised corn (Indian), pumpkins, &c., all the labour being performed by the women. They have been since exterminated by the small-pox; only thirty, it is stated by Catlin, having survived, and these were killed by the Sioux. A smaller tribe, *Minatarees*, were their allies, or dependents, and have shared the same fate.

The *Micmacs* are a small tribe still existing in Nova Scotia. They exhibited themselves and their war-dance to the Prince of Wales on his visit to America in 1860.

The *Monquois* or *Monkey* Indians, inhabit a district south-west of Lake Utah. Little is known of them, but they are said to be as light-coloured as Spaniards, neat in their dress, decorous in their manner, and their women to be beautiful. A theory has been raised that they are the descendants of the Welsh colony led by Madoc, though others suppose the Mandans to have a better claim. Not enough is known of either to warrant a conclusion, and further acquaintance will probably strip them of some of their favourable attributes.

The *Ojibbeways* dwell east of the Rocky Mountains, round the upper part of the Missouri at its junction with the Yellow-Stone. They are undoubtedly a branch of the Chippeways; and are amongst the best-formed, and the most picturesque in their dress of any of the Indian tribes. They live in a country well-stocked with game, are of robust make, and of middle stature. They number not more than 1500.

The *Osages*, a powerful and warlike tribe, are found chiefly about the Osage and White rivers, on the western borders of Missouri and Arkansas. They hunt the buffalo, but raise some maize. The *Kansas*, their neighbours, may be a part of the same tribe, as they resemble each other closely, the Kansas ranging along the river of that name and its tributary streams. Together they number upwards of 5000.

The *Pawnees* (who are not to be confounded with the Pawnee Picts, mentioned before) are a numerous tribe of 16,000 souls. They dwell in the plains between the Platte or Nebraski river and the Missouri, in lat. 42° N. and long. 25° to 28° W. They are horsemen, and depredators.

The *Potawattomies* and *Miamis* roam about the district west of Indiana, on the Wabash River, south of Lake Michigan, and number about 7000.

Sacs and *Foxes* inhabit the district west of Wisconsin. They are brave and dangerous, and number upwards of 5000 souls, but they sold their hunting-grounds, 256,000 acres, on the Ioway River, and migrated.

The *Seminoles* were once a powerful tribe in Florida, and gave much trouble to the State. They still amount to 5000 in number, but have been removed by the United States government.

The *Sioux* or *Dacotas* are by far the most numerous race of the Indian tribes, numbering it is said 27,000 souls. Their territory is a wide one, extending from about 40° 30′ to 42° 15′ N. lat., and from the Mississippi to the Rocky Mountains west. The principal settlement is at the mouth of the Teton river on the Upper Missouri. They are horsemen, well armed, constantly in hostility with the fur-hunters of the west, and with most of the neighbouring tribes, especially with the Blackfeet.

The *Snakes*, or *Shoshonees*, living in the neighbourhood of the Snake river are one of the principal tribes of the southern or American portion of Columbia. They probably amount to about 20,000 souls. The Snakes are the remains of a tribe driven by the Blackfeet from their old possessions on the Missouri. A part of them are called *Shooshooks* or *Diggers*, a degraded race, living on wild roots, whence their name. They are all a poor and depressed race, living chiefly on fish, and often subjected to great privation. Another tribe, the *Flatheads*, higher up among the roots of the Rocky Mountains, between Lewis river and Clarke's river, a much finer race of men, do not artificially flatten the skull. They are associated with the *Nez Perces*, and the *Clamets* or *Tootonez*, on the borders of North California. They are hunters and fishers, possessed of a few horses, but live during the winter chiefly on roots. They number probably altogether about 8000 souls.

The *Winnebagoes* and *Menemonies* dwell in the country east of the Mississippi, and west of Green Bay, about the Wisconsin and Fox rivers, but chiefly at the Prairie des Chiens. They were once powerful tribes, but are now reduced, and number about 4000 souls.

The government of the United States have removed the greater part of the native Indians who were dwelling within their dominions to a territory west of the states of Missouri, Arkansas, and Louisiana; extending thence to Texas and the Rocky Mountains. From north to south they are located in the following order:—the Kickapoos, on an affluent of the Missouri, in about N. lat. 41°; the Delawares, Shawnees, Kaskaskias, Piankeshaws and Weahs, Oneidas, Tuskaruras and Quapaws, Senecas, Shawnees, Cherokees, Creeks, Seminoles, Choctaws, and Chickasaws, in about N. lat. 32°. In 1853 the Commissioner of Indian Affairs estimated the total number of Indians in the United States at 400,764, of whom 271,930 were in California, Oregon, Texas and New Mexico. At that date the Indians of the old states had decreased 532 from the number in 1828. [Indian Territory, in Geog. Div.]

There still remain a great number of tribes, consisting of small numbers, who chiefly inhabit the same regions. It must be borne in mind also that the population given is only an estimate made at various times, and is almost constantly decreasing. Even the places they inhabit can only be vaguely indicated, as they are constantly trespassing on each other's grounds, which are much intermixed, and the weaker are uniformly dispossessed by the stronger races, and are then forced to seek other grounds where they can more safely remain. The recent extensive emigrations also to the gold regions of California, that of the Mormons and others to Utah, and more lately the passage of many to the English settlement on Fraser's river in Columbia, have created highways through the passes of the Rocky Mountains, lessening the dangers from the predatory habits of the Indians, still more weakening their powers of offence, and gradually reducing their numbers.

NOSO'LOGY (from *νόσους* and *λόγος*) is the term applied to the classification and arrangement of diseases. It was early found in the observation of the symptoms of disease, that many of them recurred again and again, and this led to the assigning to such groups of symptoms particular names. Thus we find that the term fever was early applied to designate a certain set of symptoms, and, as any of these symptoms preponderated, the fever obtained a specific name, as putrid fever, petechial fever, &c. But not only were symptoms had recourse to for the purpose of distinguishing peculiar forms of fever, but the causes and the locality were frequently employed; thus marsh, jail, hospital, and other fevers have been described. In this way the materials were early accumulated for the formation of a system of nosology. It was not, however, till comparatively modern times, that anything like a scientific system of arrangement was proposed. One of the earliest of these was that of Sauvages, who, taking the most prominent symptoms of diseases as his guide, divided them into ten great classes which he named Vitia, Febres, Phlegmasiæ, Spasmi, Anhelationes, Debilitates, Dolores, Vesaniæ, Fluxus, and Cachexiæ. Under these classes were arranged various orders: thus, under the first class Vitia, he arranged the orders, Maculæ, Efflorescentiæ, Phymata, Extrescentiæ, Cystides, Ectopiæ, Plagæ. The order Maculæ was divided into the diseases Leucoma, Vitiligo, Ephelis, Gutta rosea, Nævus, and Ecchymoma. This classification of diseases was followed by those of Linnæus, Vogel, Sager, and Macbride, but in their arrangements they all recognised the same principle of classification as Sauvages, and made their division of diseases to depend on the greater or less prominence of particular symptoms. All these systems, were, however, supplanted by that of Cullen, which he promulgated in the second edition of his 'Synopsis Nosologicæ Methodicæ.' The following plan will give an idea of its structure:—

Class I.—Pyrexiæ.

Order I.

Febres.

§ 1. *Intermittentes.*

1 Tertiana
2 Quartana
3 Quotidiana

§ 2. *Continuæ.*

4 Synocha
5 Typhus
6 Synochus

Order II.

Phlegmasiæ.

7 Phlogosis
8 Ophthalmia
9 Phrenitis
10 Cynanche
11 Pneumonia
12 Carditis
13 Peritonitis
14 Gastritis
15 Enteritis
16 Hepatitis
17 Splenitis
18 Nephritis
19 Cystitis
20 Hysteritis
21 Rheumatismus
22 Odontalgia
23 Podagra
24 Arthropousis

Order III.

Exanthemata.

25 Variola
26 Varicella
27 Rubeola
28 Scarlatina
29 Pestis
30 Erysipelas
31 Miliaria
32 Urticaria
33 Pemphigus
34 Aphtha

Order IV.

Hæmorrhagiæ.

35 Epistaxis
36 Hæmoptysis
37 Hæmorrhois
38 Menorrhagia

Order V.

Profluvia.

39 Catarrhus
40 Dysenteria

Class II.—Neuroses.

Order I.

Comata.

41 Apoplexia
42 Paralysis

Order II.

Adynamiæ.

43 Syncope
44 Dyspepsia

45 Hypochondriasis
46 Chlorosis

Order III.

Spasmi.

47 Tetanus
48 Convulsio
49 Chorea
50 Raphania
51 Epilepsia
52 Palpitatio
53 Asthma
54 Dyspnœa
55 Pertussis
56 Pyrosis
57 Colica
58 Cholera
59 Diarrhœa
60 Diabetes
61 Hysteria
62 Hydrophobia

Order IV.

Vesaniæ.

63 Amentia
64 Melancholia
65 Mania
66 Oneirodynia

Class III.—Cachexiæ.

Order I.

Marcores.

67 Tabes
68 Atrophia

Order II.

Intumescentiæ.

§ 1. *Adiposæ.*

69 Polysarcia

§ 2. *Flatuosæ.*

70 Pneumatosis
71 Tympanites
72 Physometra

§ 3. *Aquosæ.*

73 Anasarca
74 Hydrocephalus
75 Hydrorachitis
76 Hydrothorax
77 Ascites
78 Hydrometra
79 Hydrocele

§ 4. *Solidæ.*

80 Physconia
81 Rachitis

Order III.

Impetigines.

82 Scrofula
83 Syphilis
84 Scorbutus
85 Elephantiasis
86 Lepra
87 Frambœsia
88 Trichoma
89 Icterus

Class IV.—Locales.

Order I.

Dysæsthesiæ.

90 Caligo
91 Amaurosis
92 Dysopia
93 Pseudoblepsis
94 Dysecoea
95 Paracusis
96 Anosmia
97 Agheustia
98 Anæsthesia

Order II.

Dysorexiæ.

§ 1. *Appetitus erronei.*

99 Bulimia
100 Polydipsia
101 Pica
102 Satyriasis
103 Nymphomania
104 Nostalgia

§ 2. *Appetitus deficientes.*

105 Anorexia
106 Adipsia
107 Anaphrodisia

Order III.

Dyscinesiæ.

108 Aphonia
109 Mutitas
110 Paraphonia
111 Psellismus
112 Strabismus
113 Dysphagia
114 Contractura

Order IV.

Apocenoses.

115 Profusio
116 Ephidrosis
117 Epiphora
118 Ptyalismus
119 Enuresis
120 Gonorrhœa

Order V.

121 Obstipatio
122 Ischuria
123 Dysuria
124 Dyspermatismus
125 Amenorrhœa

Order VI.

Tumores.

126 Aneurisma
127 Varix
128 Ecchymoma
129 Scirrhus
130 Cancer
131 Bubo
132 Sarcoma
133 Verruca
134 Clavus
135 Lupia
136 Ganglion
137 Hydatis
138 Hydarthrus
139 Exostosis

Order VII.

Ectopiæ.

140 Hernia
141 Prolapsus
142 Luxatio

Order VIII.

Dyalyses.

143 Vulnus
144 Ulcus
145 Herpes
146 Tinea
147 Psora
148 Fractura
149 Caries

It was the simplicity of this system which recommended it to general adoption, and which has caused it to exercise so great an influence over other systems of pathology. At the same time it will be seen that this and the previous systems are purely artificial, and frequently bring together diseases of a very dissimilar character. Such systems have also led to the impression that diseases have a character as definite as the objects of natural history, and that a species in the one can be as easily defined as the species of another. But it becomes evident, after a little inquiry, that, with the exception of those diseases that depend on a specific contagion, no part of the idea of a species as applied to plants or animals can be made use of to designate particular diseases.

With the progress of a sound knowledge of physiology and pathology, many attempts have been made to give a more natural arrangement of diseases than that of Cullen. Dr. Mason Good divided diseases into the following six classes:—

Class I.—*Cœliaca.* Diseases of the digestive functions.
Class II.—*Pneumatica.* Diseases of the respiratory function.
Class III.—*Hæmatica.* Diseases of the sanguineous function.
Class IV.—*Neurotica.* Diseases of the nervous function.
Class V.—*Genetica.* Diseases of the sexual function.
Class VI.—*Eccritica.* Diseases of the excernent function.

This system, however successful it may be regarded in its primary divisions, was too technical in its details to be very generally employed. One of the most simple of natural classifications founded on pathological distinctions is that of Pinel, who divides diseases into fevers, inflammations, hæmorrhages, neuroses, and organic affections.

The necessities of the statist have introduced a nosology in England, which in a little time is likely to supplant all others. Already parts of this system have been adopted by medical writers, and in one instance, an entire treatise on medicine has been founded on it, so that although it has not yet found its way into the bulk of medical treatises, there can be no doubt that it is destined to exercise a considerable influence in the classification of disease. The system is that of Dr. William Farr, and is the one adopted by the Registrar General in his weekly, quarterly, and annual reports on the mortality of London and England.

Class I.—Zymotic Diseases.

Diseases that are either epidemic, endemic, or contagious, induced by some specific body, or by the want of food, or by its bad quality.

Order I.

Miasmatic Diseases.

Small pox
Varioloid disease
Chicken pox
Miliaria
Measles
Scarlatina
Hybrid of Measles and Scarlet fever
Dengue
Quinsy
Diphtheria
Mumps
Croup
Hooping cough
Typhoid fever
Relapsing fever
Typhus fever
Erysipelas
Erythema
Hospital gangrene
Pyemia
Metria
The Plague
Carbuncle
Boil
Influenza
Dysentery
Diarrhœa
Cholera
Yellow fever
Remittent fever
Crimean fever
Hong Kong fever, &c.
Ague
Rheumatism

Order II.

Enthetic Diseases.

Syphilis, primary
Syphilis, secondary
Gonorrhœa
Leprosy (including the Greek elephantiasis, and the leprosy of Moses)
Yaws
Pellagra
Radesyge
Purulent ophthalmia
Glanders
Hydrophobia
Nerenica
Malignant pustule

Order III.

Dietic Diseases.

Famine Fever
Scurvy
Purpura
Rickets
Bronchocele
Cretinism
Alcoholism
Delirium tremens

Order IV.

Parasitic Diseases.

Thrush
Porrigo
Scabies
Phthiriasis
Worms
  a Hydatids
  b Tape worms
  c Strongylus gigas
  d Round worm
  e Thread worm
  f Guinea worm

Class II.—Constitutional Diseases.

Sporadic diseases affecting several organs, in which new morbid products are often deposited, sometimes hereditary.

Order I.

Diathetic Diseases.

Gout
Anæmia
Dropsy
Cancer
Melanosis
Lupus
Canker
Mortification
Dry gangrene

Order II.

Tubercular Diseases.

Scrofula
Mesenteric tuberculosis
Tubercular peritonitis
Phthisis
Hydrocephalus

Class III.—Local Diseases.

Sporadic diseases in which the functions of particular organs or systems are disturbed or obliterated with or without inflammation; sometimes hereditary.

Order I.

Brain Diseases.

Meningitis
Encephalitis
Cephalitis
Myelitis
Apoplexy
Paralysis
Shaking Palsy
Chorea
Delirium tremens
Mania
Monomania
Dementia
Epilepsy
Hysteria
Tetanus
Convulsions
Laryngismus
Neuralgia }
Tic-doloureux }
Neuroma

Order II.

Heart Diseases.

Carditis
Pericarditis
Endocarditis
Valvular disease of heart
Hypertrophy of heart
Atrophy of heart
Fatty degeneration of heart
Aneurism of heart
Aneurism of aorta
Angina pectoris
Fainting
Arteritis
Atheroma
Phlebitis
Varicose veins

Order III.

Lung Diseases.

Hæmoptysis
Laryngitis
Laryngismus
Bronchitis
Pleurisy
Hydrothorax
Empyema
Pneumothorax
Apoplexy of lungs
Pneumonia
Pleuro-pneumonia
Asthma
Emphysema of lungs
Grinders' asthma
Miners' asthma
Colliers' phthisis

Order IV.

Bowel Diseases.

Glossitis
Stomatitis
Pharyngitis
Œsophagitis
Gastritis
Enteritis
Peritonitis
Ileus
Constipation
Intussusception
Dyspepsia
Pyrosis
Gastralgia
Hæmatemesis
Melæna
Bronzed skin
Pancreatic disease
Splenitis
Hepatitis
Jaundice
Gallstones
Cirrhosis
Ascites

Order V.

Kidney Diseases.

Nephritis
Ischuria
Diuresis
Bright's disease }
Albuminuria }
Diabetes
Stone
Gravel
Hæmaturia
Cystitis

Order VI.

Genetic Diseases.

Varicocele
Orchitis
Hydrocele
Hysteritis
Uterine tumours
Ovarian tumours
Ovarian dropsy

Order VII.

Bone and Muscle Diseases.

Synovitis
Ostitis
Exostosis
Brittle bones
Soft bones
Spinal curvature
Caries
Necrosis
Muscular atrophy

Order VIII.

Skin Diseases.

Roseola
Urticaria
Eczema
Herpes
Pemphigus
Rupia
Ecthyma
Impetigo
Acne
Mentagra
Lichen
Prurigo
Psoriasis
Pityriasis
Icthyosis
Phlegmon
Whitlow

Class IV.—Developmental Diseases.

Special diseases, the incidental result of the formative, reproductive, and nutritive processes.

Order I.

Developmental Diseases of Children.

Stillborn
Premature birth
Atelectasis
Malformation
Cyanosis
Spina bifida
Imperforate Orifices
Idiotcy
Congenital deaf-dumbness
Teething

Order II.

Developmental Diseases of Women.

Chlorosis
Childbirth
Paramenia
Climacteria

Order III.

Developmental Diseases of Old People.

Old age

Order IV.

Diseases of Nutrition.

Atrophy
Asthenia

NOTARY. This word is derived from the Roman name *notarius*, a person who was so called from his taking down in notes or writing (notæ) the words of a speaker. The *notarii* were in fact short-hand writers, for it is clear from many passages of ancient writers that they used symbols of abbreviation.

> "Hic et scriptor erit felix cui litera verbum est,
> Quique notis linguam superet cursumque loquentis,
> Excipiens longas nova per compendia voces."
> Manilius, 'Astronom.'

> "Currant verba licet, manus est velocior illis,
> Nondum lingua suum, dextra peregit opus."
> Martial, 'Epig.,' xii. 208.

It seems that they were also employed to take down a man's will in writing. The notarii were often slaves. The word is also sometimes used to designate a secretary to the princeps or emperor. (Ausonius, *Epig.*, 136; Gregor. Nazianz., in the letter inscribed *τῶι Νοταρίωι*; Augustine, lib. ii., 'De Doctrinâ Christianâ;' *Dig.* 29, tit. 1, sec. 40; Lampridius, *Alex. Sev.*, 28; see also the references in Facciolati, *Notarius*.)

In the fourth century, the notarii were called Exceptores, and were employed by the governors of the Roman provinces to draw up public documents. But the persons mentioned under the later Roman law, who corresponded most nearly to the modern notary, are called tabelliones. Their business was generally to draw up contracts, wills, and other instruments. The forty-fourth Novel treats specially of them (*περὶ τῶν συμβολαιογραφῶν*); and they are spoken of in various other parts of the Novels, and in the Code. (*Cod.* xi. tit. 53, &c.) It appears clear that as the word notarius is the origin of the modern term notary, so the tabellio is the person from whom were derived the functions of the modern notary public.

It is impossible to say when persons under the name and exercising the functions of notaries were first known in England. Spelman cites some charters of Edward the Confessor as being executed for the king's chancellor by notaries. (*Gloss.* tit. *Notarius.*) "Notaries," are mentioned with "procurators, attornies, executors, and maintainours," in the stat. of 27 Edward III. c. 1. They were officers or ministers of the ecclesiastical courts, and may therefore have been introduced into this country at a very early period. It is generally supposed that the power of admitting notaries to practice was vested in the archbishop of Canterbury by the 25 Hen. VIII. c. 21, s. 4. The term of service and the manner of admission to practice are now regulated by the 41st Geo. III. c. 79, which prescribes that no person in England shall act as a public notary or do any notarial act unless he is duly sworn, admitted, and enrolled in the court wherein notaries have been accustomarily sworn, admitted, and enrolled. He must also have been bound by contract in writing to serve for seven years to a notary, or to a scrivener using his art and mystery according to the privilege and custom of the city of London. Persons who act as notaries for reward, without being properly admitted and enrolled, are liable for every offence to forfeit the sum of 50*l.*; but British consuls abroad are empowered to perform notarial acts (6th Geo. IV. c. 87, s. 20). The licence or commission for acting as a notary in England requires a stamp duty of 30*l.*, and in Scotland one of 20*l.* The annual certificate is the same as for attornies. By 3 and 4 Will. IV. c. 70, the provisions of 41 Geo. III., so far as relates to the apprenticeship for seven years, are confined to London and Westminster, Southwark, and a circuit of ten miles from the Royal Exchange in London; and the master of the Court of Faculties of the archbishop of Canterbury is empowered to appoint and admit any attorney, solicitor, or proctor, not residing within the above-mentioned limits, to be a notary public, to practise within any district in which he shall see good reason for making such appointment.

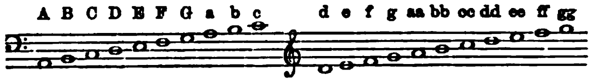
The original business of notaries was to make all kinds of legal instruments; they are often spoken of in former times as the persons who made wills (Shepherd's *Touchstone*, vol. ii. 407, Preston's ed.); but the attorney and conveyancer have now got possession of this part of their business. In practice their business is now limited to the attestation of deeds and writings for the purpose of making them authentic in other countries, but principally such as relate to mercantile transactions. It is also their business to make protests of bills of exchange. They also receive and take the affidavits of mariners and masters of ships.

NOTATION. [Symbols.]

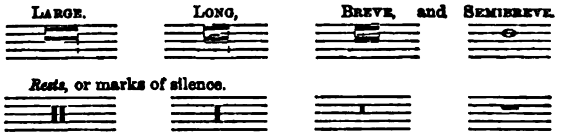
NOTATION, CHEMICAL. [Chemical Formulæ.]

NOTATION, in music, signifies the method whereby the pitch, or tune, and duration of musical sounds are represented, and by which definite periods of silence, called *rests*, are marked. It is to music what letters and punctuation are to language.

To show the pitch, the Greeks used the letters of their alphabet, placed in various positions. [Music.] The Romans had recourse to the majuscules of their own alphabet for the same purpose, till the latter part of the 6th century, when St. Gregory, or Pope Gregory I., employed the first seven capital Roman letters for the first septenary, beginning with the A answering to the lowest space in our base clef. For the next ascending septenary he used the corresponding small letters; and the third he denoted by the same small letters doubled. Example, explained in modern notation:—



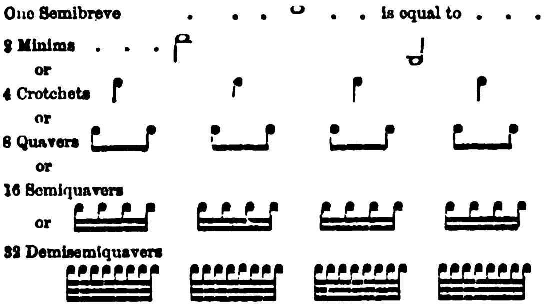
Guido, early in the 11th century, introduced, it is commonly supposed, the use of points instead of letters, which he placed on parallel lines, giving names to the latter by means of letters, which have since been gradually transformed into those signs called clefs. [Guido, in Biog. Div.; Gamut; Clef.] The dots, however, of Guido only marked the degrees of high and low; to Franco of Cologne we are indebted for characters which at once denoted both the tune and time of the sounds. [Music.] Of these he invented four, and their rests; namely, the—



These were valued or measured by the semibreve. The breve was equal to two semibreves, the long to four, and the large to eight. [Long, &c.] The invention of the minim, crotchet, quaver, and semiquaver, is ascribed to John de Muris, a doctor of the Sorbonne, who made this important addition to notation, and also originated certain characters determining the measure, in the year 1338. The demisemiquaver first appeared in the 17th century, and about the middle of the last was divided into halves. Latterly it has been subdivided into quarters, and even into eighths, most unnecessarily, and greatly to the perplexity of the performer, and, consequently, to the detriment of the art, by wantonly, and with mischievous affectation, throwing difficulties in the way of its attainment.

We have not been able to ascertain at what time the sharp and flat were brought into use. The sharp was at first square in form, according to Butler ('Principles,' &c., 1636). The flat was always a small *b*. The natural is, comparatively, of modern date. Till towards the close of the 17th century, the secondary use of the sharp was to contradict the flat, and of the flat to contradict the sharp. The natural, introduced at nearly the same time, relieved the two other characters from part of their duty. In the printed score of Lully's opera, 'Persée,' dated 1684, the natural does not appear; nor even in his 'Armide,' published in 1710. In Purcell's 'Diocletian' (1691) sharps and flats contradict each other; but the natural is occasionally used. [Sharp; Flat; Natural.] The grouping of quavers, &c., by means of ligatures, or ties, joining the stems, is also one of the improvements made in the latter half of the 17th century. It does not seem to have been practised in 1653, when Lawes printed his 'Ayres,' &c. In Lully's 'Proserpine' (1680) we find quavers tied at the bottom of their stems, in groups of four, but semiquavers are all detached. The use of bars became general about the middle of the 17th century, though this mode of division was partially adopted much earlier. [Bar; Abbreviations; Dot; Note; Time.]

NOTE, in music, a character which, by its place on the staff, represents a sound, and by its form determines the time or continuance of such sound. There are six notes in ordinary use—the semibreve, minim, crotchet, quaver, semiquaver, and demisemiquaver. To these may be added the breve, yet met with in sacred music; and the half-demisemiquaver, much used, and often unnecessarily, by the moderns. [Breve; Semibreve, &c.] The value or length in time of the semibreve may be considered as unity: the minim is $\frac{1}{2}$, the crotchet $\frac{1}{4}$, the quaver $\frac{1}{8}$, the semiquaver $\frac{1}{16}$, and the demisemiquaver $\frac{1}{32}$. Hence is formed the following *Table of Proportions*, as it is denominated:—



And hence it will also appear, that one minim is equal to two crotchets, &c.; one crotchet to two quavers, &c., &c.

The word *note* is frequently used as a synonym of sound; thus we say a high, low, loud, or soft *note*, or the *note* A; a flat *note*, &c. Some confusion occasionally arises out of this double meaning; but the musical nomenclature is very imperfect, and any attempt to improve this or any other branch of the art meets with little support from its professors.

NOTHING. In the article INFINITE will be found as much upon this word as will enable us to dispense with the consideration of the symbol 0, as the limit approached but never attained by the continual diminution of magnitude.

Among the terms used in mathematical language are *nothing*, *cipher*, and *zero*. The etymologies of the two latter terms are explained under those heads: their meanings are somewhat different. The first word, *nothing*, implies the absence of all magnitude, but its occurrence denotes either that magnitude did exist, or might have existed, or does exist, under similar circumstances in other problems, or in the same problem under different points of view. Were it not for this, the word would be useless: thus we do not consider it necessary to speak of 20*l.* generally as twenty pounds, no shillings, no pence, and no farthings. But if this 20*l.* had been the amount of a number of sums, the symbol £20 0 0 would be useful as indicating that the results of an operation (addition) had left no quantities in places where beforehand quantity might have been expected. The term *unity* would have been useless in the same manner, except as a tacit reference to other units; anything we please is *one* of its kind, and accordingly the indefinite article (a or an), which is certainly *one* in etymology, has lost its definite monadic signification, because such signification is useless. This point is of some importance to the mathematician, as justifying a use of the symbol 0 where it might seem redundant. The 0 and 1 are frequently useful as symbols of distinction where they are not wanted as symbols of operation: in like manner, in common language, the simple phrase "*one* ox and *no* sheep," though it implies no more of positive conception than the more simple phrase "an ox," may be a proper description where the second would be no such thing.

The *cipher* is 0 considered in a purely arithmetical point of view, as the mode of denoting a blank column intervening between, or following, or even preceding, columns which contain significant numbers.

The term *zero* considers 0 rather as a starting point of magnitude than as the symbol for the recognition of absence of all magnitude, and really denotes, not the entire absence of magnitude, but the arbitrary determination to reckon all magnitudes by their excess or defect from a certain zero magnitude. Thus the zero point of the thermometer does not mean that shown when there is no temperature, but a certain temperature, that of freezing water; and degrees above and below zero indicate excesses or defects of temperature above or below that standard. It is then perfectly proper to say that ten degrees below zero is a lower temperature than five degrees, and that both are less than zero. Whenever magnitude is considered in connection with modifications, the zero and even the nothing of such magnitude may require to be considered with similar modifications, even though all absolute magnitude is lost. Straight lines, for example, admit of consideration with reference not only to their lengths, but also to their positions and directions. Let the straight lines diminish each by an approach of one extremity towards the other, and position and direction still always distinguish each line from the others, though all be of the same linear magnitude (length); when the one extremity actually reaches the other, length is destroyed, but one indication of position still remains, the fixed extremity, or what was the fixed extremity so long as the line had length. Different points (*nothings* of length) still tell something about the positions of the different lines which left them; and there are as many *nothings* of length (distinguishable) as there are different points in space. These zeros, as it might be proper to call them, are of most essential consequence, *as zeros*, in the complete method of connecting the explanations of symbols in algebra (in the widest sense of the term) with those of the restricted or arithmetical sense. [ALGEBRA.] All direction however has disappeared when a line is reduced to a point; and considerations arising out of this, the principles of which appear in FRACTIONS, VANISHING, will be applied in the article TANGENT.

It might seem as if, in the consideration of the term *zero*, we had commenced an explanation of negative quantities, and had obtained a justification of the phrase *less than zero*, if not of *less than nothing*. This may be true to a certain extent, too limited however for the purposes of algebra, and not sufficiently expressive of the actual meaning of the words. When the distinction of positive and negative quantities is explained and adopted, the terms greater and less are no longer used in their simple arithmetical meaning, but take a wider signification, such as will allow old theorems of arithmetic to remain true under the same phraseology as before. After an express extension of signification has been accorded to these terms, it is not wonderful that uses of them should be perfectly allowable which could not be made if we retained the old significations. Those who use the extended meanings, without fully understanding and admitting them, will make a mystery of algebra: those who refuse to make the extensions, and yet charge others who do not refuse with falling into all the absurdities which extended uses without extended meanings present to *themselves*, are precisely in the condition of the honest tar who asserted that the French were such fools as not to know the difference between a cabbage and a shoe (*chou*). But those again who, professing to use extended meanings, do not take care to make their logic conformable to them, but neglect to distinguish between premises which are true of one set of meanings and not of the other, will fall into such mistakes as would be made by him who should conclude that blood is salt water, because both circulate in arms (of the human body and of the sea).

Admitting the scale of positive and negative numbers,

$$\ldots -3, -2, -1, 0, +1, +2, +3, \ldots$$

it is obvious that on the right of 0, on which we have quantities common to pure arithmetic and algebra, we pass from the greater to the less by moving our eyes from right to left; while on the left we have no meaning at all of greater and less yet established. Let us agree then that we are to pass from what we will call the greater to what we will call the less by passing from right to left in all cases; and there is no mystery in our meaning when we say that all negative quantities are less than 0, and that -10 is less than -5.

But is this convention a purely arbitrary one? We answer that it rather bears the character of interpretation [INTERPRETATION] than of convention. Having new modes of quantity, with corresponding extensions of addition and subtraction, we are rather to ask what greater and less *ought* to mean than what, with liberty of choice, we shall make them mean. The great characteristics of greater and less (or more and less) in arithmetic are, that the more you add the more you get; and that the more you take away the less you leave, and *vice versâ*. The preceding extensions of greater and less are the only ones which will allow of these theorems remaining universally true. Thus

$$3+(-5)=-2, \text{ add more, and } 3+(-4)=-1,$$

and -1 is greater than -2. Again,

$$-5-(-12)=7, \text{ subtract less, } -5-(-13)=8,$$

and 8 is greater than 7.

It is however to be remembered, though no rule has been laid down upon the subject, that it may be gathered from the practice of writers that the terms *smaller* and *diminution* do not accompany *less* in its extended meaning. The former term is particularly used in the Differential Calculus to denote an approach to 0, which in a negative quantity is algebraic increase, and in a positive quantity diminution. And many, perhaps all, writers on the Differential Calculus, are lax in their use of all the comparative terms, sometimes employing them in the algebraical and sometimes only in the arithmetical sense. The inconvenience is not very great, as a student must have learned to contend with greater difficulties than those of an unexplained use of dubious terms, before he is able to make his way to the higher mathematics. But it may be useful to give him a hint that, in reading works of analysis, he would do well at first always to stop for a moment when the word greater or less occurs, and ask himself whether the problem requires and allows the extended signification or not, and to make some mark of distinction in every place. This will at once ensure the soundness of the first reading, and facilitate the second.

NOTHING, DIFFERENCES OF. This name is given to certain numbers which are used in so many different theorems that it is worth while to tabulate them, and to consider them as fundamental numbers of reference. They were first specifically noted in this point of view by the late Bishop Brinkley. We shall here confine ourselves to a description of their derivation, an expeditious mode of calculating them, a table of some of their values, and one instance of their use.

If we take a series of terms a, b, c, e, &c., and form the successive differences of a [DIFFERENCES, CALCULUS OF], the symbols Δa, $\Delta^2 a$, &c., have a meaning which refers to the excess of b above a, &c. If then a should happen to be $=0$, the symbols $\Delta 0$, $\Delta^2 0$, &c., may stand for finite quantities: for instance in—

$$\begin{array}{cccc} 0 & & & \\ & 2 & & \\ 2 & & 1 & \\ & 3 & & 0 \\ 5 & & 1 & \\ & 4 & & 0 \\ 9 & & 1 & \\ & 5 & & \\ 14 & & & \end{array} \text{ \&c.} \quad \Delta 0=2, \quad \Delta^2 0=1.$$

But as the preceding series is a set of values of $\frac{1}{2}x(x+1)-1$, in which the first term is 0 ($x=1$ gives $\frac{1}{2}1.2-1$), it would be necessary in using several series beginning with 0, to make marks of distinction between $\Delta 0$ in one series, and that in another. The most useful case is that in which whole and positive powers of 0, 1, 2, 3, &c., form the series in question: thus if we take the series of cubes,

$$\begin{array}{lccccc}
0^3 = & 0 & & & & \\
 & & 1 & & & \\
1^3 = & 1 & & 6 & & \\
 & & 7 & & 6 & \\
2^3 = & 8 & & 12 & & 0 \\
 & & 19 & & 6 & \\
3^3 = & 27 & & 18 & & 0 \\
 & & 37 & & 6 & \\
4^3 = & 64 & & 24 & & \\
 & & 61 & & & \\
5^3 = & 125 & & & &
\end{array}
\qquad
\begin{array}{l}
\Delta . 0^3 = 1 \\
\Delta^2 0^3 = 6 \\
\Delta^3 0^3 = 6 \\
\Delta^4 0^3 = 0, \text{ \&c.}
\end{array}$$

The symbol $\Delta^m 0^n$, whenever m is greater than n, stands for 0; when m is $= n$ it stands for $1 \times 2 \times 3 \times \ldots . \times n$. In all other cases the differences of 0^{n+1} may be found from those of 0^n by the following equation:—

$$\Delta^r 0^{n+1} = r\left\{\Delta^{r-1} 0^n + \Delta \ 0^n\right\}$$

It is frequently useful to have the term $\Delta^r . 0^n \div 1 . 2 . 3 \ldots (r-1) . r$ arranged in tables. If we wish to make this separately, we have, denoting the preceding fraction by $\Delta^{(r)} . 0^n$

$$\Delta^{(r)} 0^{n+1} = \Delta^{(r-1)} 0^n + r\,\Delta^{(r)} 0^{n-1}$$

The following table contains both the differences, and the differences divided, as just explained, up to those formed from the series of tenth powers; arranged so that simple differences must be looked for above or on the dotted lines, and divided differences below the dotted lines; the first by means of the left hand column and highest row; the second by the right hand column and lowest row. Thus—

$$\Delta^5 0^8 = 126000 \ , \ \frac{\Delta^5 0^8}{2.3.4.5} = 1050$$

$$\Delta^6 0^7 = 15120 \ , \ \frac{\Delta^6 0^7}{2.3.4.5.6} = 21$$

n	Δ	Δ^2	Δ^3	Δ^4	Δ^5	Δ^6	Δ^7	Δ^8	Δ^9	Δ^{10}	n
10	1	1022	55980	818520	5103000	16435440	29635200	30240000	16329600	..3628800	1
9	1	510	18150	186480	834120	1905120	2328480	1451520	..362880	1	2
8	1	254	5796	40824	126000	191520	141120	...40320	3	1	3
7	1	126	1806	8400	16800	15120	...5040	6	7	1	4
6	1	62	540	1560	1800	720	10	25	15	1	5
5	1	30	150	240	120	15	65	90	31	1	6
4	1	14	36	24	21	140	350	301	63	1	7
3	1	6	6	28	266	1050	1701	966	127	1	8
2	1	...2	36	62	2646	6951	7770	3025	255	1	9
1	..1	45	750	880	22827	42525	34105	9330	511	1	10
n	Δ^{10}	Δ^9	Δ^8	Δ^7	Δ^6	Δ^5	Δ^4	Δ^3	Δ^2	Δ	n

The only one not in the table is $\Delta^{(r)} 0^r$ which is always unity.

The uses of these differences mainly consist in the rapidity with which transformations can be made by means of them, whether of a simple algebraical or of a transcendental kind: such as the following, n being a whole number:—

$$\begin{aligned}
x^n &= x + \Delta^{(2)} 0^n . x(x-1) + \Delta^{(3)} 0^n . x(x-1)(x+2), \\
&\qquad\qquad + \quad \text{\&c.} \\
x^2 &= x + x(x-1), \\
x^3 &= x + 3x(x-1) + x(x-1)(x-2), \\
x^4 &= x + 7x(x-1) + 6x(x-1)(x-2) \\
&\qquad + x(x-1)(x-2)(x-3),
\end{aligned}$$

and so on. [See also OPERATION; SERIES.]

The following works contain many properties of these numbers: Herschel, 'Examples of the Calculus of Finite Differences,' *passim*; and 'Lib. Useful Knowl.: Differential and Integral Calculus,' pp. 253-261, and 307-311.

NOTICE is a term used in English law with reference to various kinds of transactions. That use of it which is most important, and which it is here proposed to explain, has reference to contracts of buying and selling, and mainly so far as such contracts come under the cognisance of courts of equity. In this sense notice signifies the knowledge of a party to the contract of any fact which is connected with the contract, and may become a matter of dispute either between the parties to the contract, or between them or any of them and any other person not a party to that contract. The term notice is most commonly applied to buying and selling of land, or some interest in land, and the matter generally in dispute is, whether the interest of a person who is not a party to the contract is in any way to be affected by it.

Notice, in English law, is an ambiguous term, and has different meanings according as we contemplate the giver or the receiver of what is called notice. To give notice is to communicate something to another person: the person who receives the communication is said to *have* notice, and when it is proved that he has had such notice, he is presumed to have knowledge of the thing communicated. Thus notice comes to have the meaning of *knowledge* when applied to him who is the receiver of the notice; and it is not always easy to avoid the ambiguity resulting from this double meaning of the word.

Notice of a fact (notice being here considered with reference to the receiver) may mean either knowledge of the fact itself, or knowledge of some other fact from which arises a legal presumption of knowledge of the fact itself. In both cases the knowledge must be proved by evidence, and the only difference in the evidence is this; in the former case a fact is to be proved, which fact, when proved, shall be considered knowledge; and in the second case a fact is to be proved, which cannot be considered as knowledge, but is a fact the establishment of which leads to a legal presumption, that is, to an inference of some fact which is considered as knowledge. If a man receive a written communication from another person of a certain demand upon him by such person, all that can be proved by evidence is that he did receive such communication; but that fact being established, all the world imputes to the receiver of such communication knowledge of the demand contained in it. The fact, in order to have any relation to the contract, must of course be such a fact as would affect the contract if it were expressly made part of it. A fact of this kind then being established, which is either knowledge or legal presumption of knowledge, the legal conclusion is, that the person who had such knowledge at the time of making the contract must be considered as having acquiesced in such fact; in other words, such fact must be considered to have the same effect as if it were expressed in and incorporated with the contract.

Notice has been divided by writers on English law into "actual" and "constructive." Of "actual notice," it is said that "to constitute a binding notice, it must be given by a person interested in the property, and in the course of the treaty for the purchase. Vague reports from persons not interested in the property, will not affect the purchaser's conscience; nor will he be bound by notice in a previous transaction which he may have forgotten. (Lord St. Leonards, 'Vendors and Purchasers,' 13th edit. p. 621.) The same author says of "constructive notice," that "in its nature it is no more than evidence of notice, the presumptions of which are so violent, that the court will not allow even of its being controverted; but courts of equity will not extend the doctrine to cases to which it has not hitherto been held applicable." The difference between the two kinds of notice seems to be rather in degree than in kind. In addition to what has been said on the general subject of knowledge, we may take an instance of what would be called actual notice in English law. We will suppose this actual notice to be a statement in writing made by a person interested in a certain piece of land and in the course of the treaty for the purchase of it, and by him handed to the purchaser. Now it is obvious that all this, when proved, does not make the knowledge of the purchaser; but these facts, when proved, are evidence, of knowledge, "the presumptions of which are so violent" that the universal consent of mankind "will not allow even of its being controverted." There is then no further distinction between actual and constructive notice, considered as a matter belonging to the general subject of evidence, than what has been already stated; and the only question which can arise in any system of law is, what facts, not capable of being considered as knowledge, shall be considered, when proved, as leading to a legal presumption of such facts as may be considered knowledge.

These general principles will be better understood by their application to particular cases, in English law, of buying and selling land. But it should be premised that there are cases of what is often called notice, in English law, where no knowledge of anything is proved, but the existence of a certain thing is proved, and then notice is legally imputed to the person to be affected by it. Thus, when there is a public act of parliament, everybody is legally supposed to have notice of it. But this is notice which arises from positive law, and is not presumed from the proved knowledge of another fact; it would therefore be more appropriate to give it some other name, and not to confound it, as some text writers do, with that which they call constructive notice. Another example of such notice made by positive law is, where there is a suit pending* which may affect the subject of sale; in this case the purchaser is also said to have notice of it, and he buys subject to what may be decreed in the suit. All conveyances by any bankrupt *boná fide* made and executed before the date of the filing a petition of adjudication are valid, notwithstanding any prior act of bankruptcy committed by the bankrupt, provided the person to whom the conveyance is made had not at the time of such conveyance notice of any prior act of bankruptcy committed by the bankrupt.

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* By the Act 2 Vict. c. 11, purchasers and mortagees are not to be bound by *lis pendens*, of which they have not express notice, unless the names, &c., of the parties to be affected thereby are registered, as the Act prescribes.

Where facts are proved to be known to a man which are sufficient to make him inquire further, he is considered to know all that he might have known if he had made inquiry. For instance, if a man buys an estate which is in the possession of a tenant, notice of such possession is notice of any lease or other interest which the tenant may have in the estate; and though the seller may affect to sell the complete and immediate interest in the estate, the buyer will take it subject to the interest of the tenant. And if a tenant under a lease has some further interest in the land by agreement posterior to the date of the lease, the buyer of the land, who has notice of the tenant's possession, has constructive notice of such agreement, and therefore he buys the estate subject to all the tenant's rights. It will of course be observed that the contract of a purchaser with a seller cannot affect the previous contract, about the same land, of another person with the same seller, so far as the mutual rights and liabilities of the seller and that other person are concerned. But the question between the two persons who have dealt with the seller is, Which of the two is to have that thing which he has agreed to buy, and which of the two is to have the trouble of settling the dispute with the seller. It is determined that the subsequent contractor, who has what is called notice of the former contract, must be considered as having the benefit of his own contract, but still subject to the prior contract; and if he has bought the estate and obtained a conveyance of it, having notice of a prior contract for sale, he will be compelled to convey the estate to the person who had such prior contract with the vendor. If the prior contractor has obtained any legal estate in the land, the buyer, of course, whether he has notice or not, only obtains from the vendor such interest as he can sell.

That which is notice to a man's agent is notice to himself, provided the agent has the notice in the transaction in which he acts as agent. This doctrine is obviously founded on the legal identity of the principal and agent, in all matters which the principal transacts by his agent.

It seems to be determined that the mere fact of a man being witness to the execution of a deed, will not be notice to him of the contents of the deed; for the nature of that transaction called witnessing a deed is not in any way connected with a knowledge of the contents of the deed.

Sometimes a person who is entitled to a sum of money or the interest of a sum of money which is in the hands of a trustee, will fraudulently sell his interest twice over. A second purchaser, who *has* no notice of the former transaction, and *gives* notice, that is, communicates in a way that cannot be misunderstood the fact of his purchase to the trustee before the former purchaser does, is entitled to have what he has bought, in preference to the other purchaser. By *not having* notice, he purchases a good title, and acquires a right to what he has bought, equal to the first purchaser's right; by *giving* notice, he secures that which he has purchased. This is a good example of Notice, viewed under two different aspects, which should not be confounded.

Other examples of notice may be found in the text books.

It will be collected from what has been said, that cases of this kind of notice under consideration, are cases in which three persons at least are generally concerned, a seller, a buyer, and some person who is interested in disputing the buyer's title to the thing which he has bought. The term is also applied, though less frequently, to the case of a seller and buyer only; for that which may be called notice in the other case may be equally well called notice in this. The seller may not intend to conceal or misrepresent any fact, and he may think that he has said everything that was necessary, and the buyer may think that he was buying the whole of an estate when the vendor was only selling the estate subject to certain encumbrances; and the state of facts may be such as would be evidence of notice to the purchaser as against a party who had contracted with the vendor previous to himself. The question then comes, whether such state of facts is to be considered as notice to the purchaser, in the case now supposed, as against the vendor, and equally binding on him as it would be in the case of a prior contracting purchaser. It may be observed that the doctrine of notice, as between a seller and a single buyer, has been applied to the case of a lease, where it was held that notice of a lease to a purchaser was notice of its contents; but this doctrine was derived from a case wherein three parties were concerned, a seller, a lessee, and a purchaser, and it does not appear to have been considered that the question of notice between two purchasers, or two parties claiming an interest in land against a third person, is not quite the same thing as the case of a dispute between two persons only, a seller and a buyer. (Hall *v.* Smith, 14 Ve., 426, 437.) This kind of question however, in English law, would be more properly considered under the heads of Concealment, Suppression, or Misrepresentation, which are a species of fraud; or under the head of Mistake.

The question of notice is one of great practical importance. So far as relates to what shall be evidence of notice, it will vary greatly in different systems of jurisprudence; so far as concerns its true nature, it belongs to the general doctrine of contracts.

NOUN (in Grammar), the name of one of the parts of speech into which grammarians have distributed the words of a language. The noun generally expresses the subject of discourse, or the name (*nomen*) of the thing spoken of, as *horse, table, darkness,* &c.; but it may also be used as the predicate, as in the sentence, "Tin is a metal," where both "tin" and "metal" are nouns.

So far as respects the form of nouns, that is, the sounds of which they are composed, they are capable of classification in all languages. The nature of this classification may be explained from examples in our own language. Many nouns are simple roots, as *horse, ship, man, tree;* while others are formed by adding a suffix to the root or to other words. [NOTION, NOTIONAL.]

The following list of nouns, formed by suffixes, belong to the Saxon part of our language. A few examples of each suffix are given in order to show the use of each suffix more clearly :—

Er.	Ster.	Ard.	Eer.
build-er	game-ster	drunk-ard	mountain-eer
box-er	malt-ster	slugg-ard	chariot-eer
walk-er	song-ster	dast-ard	musket-eer
scoff-er	pun-ster	blink-ard	engin-eer

Some of the words in *er, ster,* and other terminations, have a corresponding feminine termination in *ess, ix,* or *stress,* as *murderess, songstress, executrix.* The termination *ix* is of Latin origin.

Ling.	Kin.	Let.
fat-ling	lamb-kin	rivu-let
first-ling	pump-kin	cut-let
dar-ling (dear-ling)	pip-kin	stream-let
fond-ling	manni-kin	is-let

These three terminations generally, but not always, give to the root the notion of smallness, and hence they belong to the class called diminutives.

Dom.	Hood.	Ness.
king-dom	boy-hood	bad-ness
wis-dom	child-hood	base-ness
prince-dom	false-hood	cold-ness
thral-dom	man-hood	dark-ness

Rick—as bishop-ric; Wick—as bail-wick.

Ship.	Th (from adjectives, with a change in the vowel).	T (mostly past participles).
friend-ship	leng-th	gif-t
hard-ship	bread-th	draf-t
partner ship	dep-th	join-t
court-ship	streng-th	thef-t

The following terminations are of Latin and Greek origin, though most of them seem to have come through the Norman portion of our language :—

Acy.*	Age.†	An or Ian.	Ance.	Ancy.‡
conspir-acy	append-age	pag-an	abund-ance	depend-ancy
fall-acy	band-age	artis-an	repent-ance	expect-ancy
suprem-acy	broker-age	guard-ian	resist-ance	occup-ancy
lun-acy	cord-age	traged-ian	observ-ance	vac-ancy

Ary.	Ate.	Ence.	Ency.
api-ary	advo-cate	consci-ence	ag-ency
lumin-ary	potent-ate	consequ-ence	clem-ency
emiss-ary	prim-ate	impot-ence	curr-ency
libr-ary	gradu-ate	infer-ence	tend-ency

Ent.	Ice.	Ics.	Ion.
correspond-ent	mal-ice	eth-ics	adopt-ion
presid-ent	just-ice	opt-ics	animat-ion
stud-ent	avar-ice	mechan-ics	anticipat-ion
ag-ent	coward-ice	phys-ics	corrupt-ion

Ism.	Ist.	Ment.	Ory.
athe-ism	bapt-ist	allure-ment	audit-ory
bapt-ism	de-ist	enjoy-ment	vict-ory
critic-ism	flor-ist	entice-ment	direct-ory
fanatic-ism	fatal-ist	frag-ment	deposit-ory

Or or Tor	Tude.	Ty.	Ure.
correct-or	alti-tude	facili-ty	depart-ure
inspect-or	forti-tude	liber-ty	fig-ure
jur-or	grati-tude	plen-ty	literat-ure
edit-or	lati-tude	civili-ty	press-ure

The preceding list contains the majority of the terminations of nouns in the English language which are not simple roots. The number, case, and gender of nouns in general are explained in the articles DUAL NUMBER, GENDER, ABLATIVE, and ACCUSATIVE CASES.

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* Usually formed from adjectives in *ate,* as accur-ate, accur-acy.

† Apparently from the barbarous Latin *agium.*

‡ Usually formed from adjectives in *ant,* as abund-ant, abund-ancy.

NOVATIANS, a Christian sect which arose in the middle of the 3rd century. Their leader, Novatianus (or as Lardner prefers to call him, following the Greek writers, Novatus), was a presbyter at Rome, who, after the death of Fabian, bishop of Rome (A.D. 250), and the election of Cornelius as his successor (A.D. 251), refused to submit to the authority of Cornelius, and procured from three bishops his own ordination as bishop of Rome. Upon this, Cornelius called a council at Rome, and excommunicated Novatian and his adherents, who immediately formed a distinct sect, and thus became schismatics. But Novatian is also reckoned as a heretic, on account of his opinions respecting those Christians who after baptism had fallen into open sin, whom he declared that the Church had not the power to admit again to her communion, even though they should give satisfactory evidence of their repentance. In consequence of this strictness of discipline, his followers obtained from the Greek writers the name of Cáthari (καθαροὶ), that is, Puritans. In other points the opinions of Novatian did not differ from those of the Catholics. Some writers charge him with unsound opinions respecting the Trinity, but there is ample evidence to disprove this accusation. His later followers condemned second marriages. Novatian is highly spoken of by the ecclesiastical writers for his learning, eloquence, piety, and exemplary conduct. It is true that Cornelius accuses him of very disreputable conduct in the means by which he obtained ordination, and in other matters; but these are the statements of a violent opponent, couched in very unmeasured language, and some of them are highly improbable.

Novatian was assisted in his proceedings by Novatus, a presbyter of Carthage, whom Cyprian calls the author of the schism; and he numbered also among his followers some bishops and several presbyters. His sect spread widely, and embraced at various times some men of very high character and attainments. The Novatians were included in the severe edict which Constantine issued, about A.D. 331, against the Valentinians, Marcionites, Cataphrygians, and other heretics; but it is thought that, through the influence which some of their leaders had with the emperor, they suffered little on that occasion. Under the Arian emperors they shared in common with the orthodox in the persecutions which they endured; but under the Catholic emperors they appear to have enjoyed repose on account of their orthodox opinions on the Trinity. This sect declined in importance during the 5th century.

Novatian wrote several works, of which there remain a treatise, 'Of Jewish Meats;' another, 'Of the Trinity,' or 'Of the Rule of Faith,' a letter of the Roman clergy to Cyprian, written during the vacancy of the see of Rome, after the death of Fabian, in August, 250. There is another letter to Cyprian, written in the same year, but it is not certain that Novatian was its author. Jerome gives a catalogue of Novatian's works, among which are two, 'Of Easter,' and 'Of Circumcision.' The Novatians asserted that their leader suffered martyrdom, but of this we have no proof.

(Eusebius, *Hist. Ecc.* vi. 43; Hieronymus, *De Vir. Illust.* chap. 70; Epiphanius, *De Hæresiis;* Lardner's *Credibility*, pt. ii. chap. 47; Mosheim's *Ecclesiastical History*, cent. iii. part ii.; Neander's *Kirchengeschichte*.)

NOVEL. It will be as well to draw a distinction at starting between romances and novels; the one term includes all fictitious narratives of the kind called romantic, whether in prose or verse; the other is used to designate that species of romance which is most common at present. Those who are accustomed to look upon all literary composition as depending for its changes on that prevalent tone and character of society, which are usually known by the name of the spirit of the age, will easily allow that imaginative writings are not excepted from the general rule; that they are in fact the expression of the age in which they appear. It remains then for us to find out, if possible, what relation they bear to that prevalent tone of society to which we have already alluded, as the spirit of the age.

A comparison between the novel and other imaginative compositions, such as narrative, lyrical, or dramatic poetry, will show that while the latter depend for their effect on our tastes and sympathies as men, the former requires us to be interested in the circumstances of the plot as well as in the characters themselves. The interest excited by the 'Iliad,' and by 'Hamlet,' exists independently of our knowledge of the history of Troy or of Denmark; and hence the universal celebrity of those poems. They have been read and will be read with delight, not only by one age or country, but by all. They exhibit pictures of *humanity;* and, as such, do not depend for their popularity on the fact of their readers being interested by the customs which they describe or the scenes in which the stories are laid. It is as a man, not as a prince of Denmark, that we are interested in Hamlet. If Hector and Andromache had been natives of the South Sea Islands, we should have read the description of their parting with as much sympathy as we do now.

In novels, on the contrary, we require, in order to be fully satisfied, to be interested in the circumstances, the dress, manners and language of the characters, as well as in the characters themselves. But these circumstances, the outward dress of the story, are precisely those parts in which the peculiarities of age and country are developed—those which render the hero of the novel an individual, not the representative of a class. If we acknowledge thus far, we shall see that the interest which the novel excites depends on more causes than that of the narrative or dramatic poem. But being a more intense, it is also a more cónfined, interest; and thus we see why the ponderous romances of the 17th century have ceased to delight the world, while the 'Iliad' is as fresh to us as it was to Plato or Cicero.

This additional source of interest however is that which depends in itself on the peculiarities of the age in which any one novel or class of novels appears. Thus the stilted romance of Elizabeth's time was the legitimate offspring of a taste then very prevalent for an ideal state of pastoral life called Arcadian. The readers in that day were the higher ranks, the court and the nobility, and the novel both led and followed their taste. In another country we find romances of chivalry particularly current when the age of chivalry was nearly passed, and when the realities of Moorish warfare had been succeeded by a fashionable enthusiasm unaccompanied by action. Such were the novels which Cervantes began by caricaturing and ended by surpassing.

Sir Walter Scott's novels are in like manner the legitimate creation of their age. Percy's 'Reliques' and some other books had given a retrospective turn to literature. Men began to find that Pope and Dryden, or even Milton, did not contain all that was worth knowing in the literature of England. A race of antiquaries sprang up, and with them an antiquarian novelist. Göthe's famous saying about Shakspere, which Carlyle has so cleverly applied to Scott,—"that Shakspere formed his characters from within outwards, Scott from without inwards," is so true, that any one who bears it in mind while reading Scott will not fail to see that the attraction of the 'Waverley novels' depends more on the dresses and decorations than on the actors.

To quote one more instance; during the first half of the last century the great object of attention was "the town," by which was meant the profligate life spent by men of fashion. A glance at the poetry of that age is enough to show that Nature had small charms for the reading public, and that fashion was then everything. If we turn to the novelists, to Richardson, Fielding, and Smollett, and then to their descriptions, can anything be more obvious, than that the external dress of the novel—that by which it is distinguished from other narrative works of imagination,—depends entirely on the age in which it is written, and is in effect a tolerably faithful but somewhat exaggerated reflection of the favourite ideal objects and pursuits of the reading classes at the time.

But there is another salient feature in the novel, which it possesses in common with the poetical romance, and which distinguishes it most completely from all classical fictions. We refer to the important part played in almost all novels by that kind of love which goes by the name of romantic.

It cannot be doubted that the influence of Christianity and of the old German spirit upon the nations of modern Europe has contributed to alter the treatment and condition of women, not only in degree but in kind. To the eye of a Roman observer, one of the most remarkable peculiarities of the German nation was the veneration paid to women, and this veneration, transmitted through generations, affected in no unfavourable degree by Christian precepts, although changing in appearance with the change of ages, still exists in that gallantry of which the Romans and Greeks seem to have been wholly ignorant, and which in the romantic novel, as being a picture of human life, plays a most important part. But it is still to be remembered that it is not the passion of love as a classical author would have described it, but the passion as developed in those nations among whom romantic tales have been principally current, which thus predominates in the romantic novel.

The popularity of novels is one of the most curious features of our literature; and it is to be observed that it is attended with an almost entire discouragement of dramatic composition, and with a marked preference on the part of those who apparently patronise the drama, for scenic effect, in place of accurate dramatic delineation of character. There is scarcely one tragedy worth mention of a date posterior to the time of Fielding. 'Philip van Artevelde,' the offspring of our day, and, although far below it in merit, Talfourd's 'Ion,' are worth notice, as well for other reasons as because they have been accompanied by an effort, in act, to redeem the stage from serving as the mere vehicle of dramatised novels. But we cannot give to 'Philip van Artevelde' the name of a drama; indeed the author himself styles it a dramatic romance; and its length and the character of many of its incidents bring it rather under the romance than the drama. We have drawn a distinction between the romance and the novel, the former being the more comprehensive word; but we must still bear in mind that a prose novel stands in the same relation to a later age that a poetical romance does to an earlier, for poetry constitutes the only possible literature of an age of reciters; and it is not until men begin to read for themselves that prose comes into being.

There is another feature about the novels of the present day which deserves especial notice, and that is the manifold forms which they assume. We have them as naval tales, military records, love stories, political memoirs, the diaries of clergymen, lawyers, and physicians, novels embodying theological disquisitions,—suited in short to every class of readers. From this we see how much the demand influences the supply, even in that most incorporeal of all manufactures, book-making. That the appetite is fed by the supply is also true, but not to an extent sufficient to justify us in supposing that the one depends entirely upon the other. The manifold character of modern romantic literature, as compared with that uniformity which distinguished the romances of the middle ages, when author after author exhausted his powers in adding to one bulky record of the fall of Troy, or the conquests of Alexander, is the last proof which we need bring to show that romances do really depend upon and go along with the prevailing tone of the age in which they appear.

It is not the province of this work to enlarge on the probable or actual effects of any course of reading, but it may be as well to point out that the injury supposed to be done to the mind by novel reading is not peculiar to any one kind of study. A constant devotion to any abstract speculation notoriously deadens the taste; and too much cultivation of any one pursuit necessarily gives the corresponding part of the mind a growth disproportionate to that of the rest. The peculiar evil of novel-reading depends on the bad quality of the food devoured, which pampers our love for ideal griefs and joys, to the prejudice of all well-organised efforts to grapple with the realities of life.

NOVELLÆ. [Justinian's Legislation.]

NOVEMBER, the eleventh month of the Julian year, was the ninth in the year of Romulus, whence it received its name. This name was assigned to it in the Alban calendar. It originally consisted of thirty days, which were continued by Romulus and Numa. Julius Cæsar gave it another day, but Augustus reduced it again to thirty, and this number it has ever since retained.

Our Saxon ancestors called November *Blot-monath* (blood-month), the month of sacrifice, because at this season the heathen Saxons made a provision for winter, and offered in sacrifice many of the animals which were then killed. This is distinctly stated in an ancient account of the Saxon months, printed in Hickes's 'Thesaurus' (vol. i., p. 219). It was common at this season to slaughter oxen, sheep, hogs, &c., for the use of the ensuing winter. The stock of salted meat prepared at this time was to last through the winter months till vegetation came again sufficiently forward to enable them to resume the use of fresh provisions. Some notion of the vast extent to which the opulent provided for themselves and their retainers at this season may be formed from the contents of the larder of the elder Spenser, in 1327, which, in the month of May, contained "the carcases of eighty salted beeves, five hundred bacons, and six hundred muttons," the reliques of his winter provisions.

Martlemass or Martinmas beef, cured about the festival of St. Martin, the 11th of this month, was a provision formerly well and in some places still known. The Spanish proverb, "His Martinmas is coming, when we shall be all hogs alike," alludes to the slaughter of swine at this period.

(Pitisci, *Lexicon Antiq. Roman.*; Bosworth's *Anglo-Saxon Dict.*; Brady's *Clavis Calendaria.*)

NOVICE, the appellation given to persons of either sex who are living in a monastery, in a state of probation previous to becoming professed members of a monastic order. Persons who apply to enter the noviciate state, on being admitted by the superior of the monastery, promise obedience during the time of their stay, and are bound to conform to the discipline of the house, but they make no permanent vows, and may leave, if they find that the monastic life does not suit them. The period of the noviciate must not be less than one year, and the person who enters as a novice must have attained the age of puberty. Richard, in the 'Bibliothèque Sacrée,' article 'Novice,' describes the qualities required according to the canons of the Council of Trent for the admission of a novice: they are health, morality, voluntary disposition for a monastic life, intellectual capacity, &c. No married person can be admitted unless by the consent of both parties; no person who is incumbered with debts, or whose assistance is necessary for the support of his parents, is admissible. Widowers and widows may be admitted as novices, unless their labour is required for the support of their children. After the termination of the year of probation, the novice, if he (or she) persists in his vocation, and his conduct and capacity have proved satisfactory, may be admitted into the order by taking the solemn vows which are binding for life. Ducange, in his 'Glossarium,' article 'Novitius,' quotes the 34th canon of the Council of Aquisgrana, A.D. 817, in which superiors of monasteries are cautioned against admitting novices with too great facility, and without a full examination of their disposition, morals, and mental and bodily qualifications. But in after-ages, as the number of monasteries was multiplied beyond measure, prudential restrictions were disregarded, and every means were resorted to in order to induce young people to enter the monastic profession, and parents often forced their children into it against their will. The misery and guilt which resulted from this practice are well known, but few perhaps have exhibited them in so vivid and fearful a light as the Italian writer, Manzoni, in his 'Promessi Sposi,' in the episode of 'Gertrude.' It was in order to guard against such abuses and their fatal results that the Council of Trent, session 25, can. 17, prescribed that female novices, after the expiration of their noviciate, should leave the walls of the monastery and return to their friends, and be carefully examined by the bishop of the diocese, or by his vicar by him delegated, in order to ascertain that they were under no constraint or deception, that they were fully aware of the duties and privations of the monastic life, and that they voluntarily chose to enter it. These humane precautions, however, have been evaded in many instances; and it may be doubted whether a very young person should be allowed to bind himself for life by irrevocable vows.

NU'CLEUS (a small nut), a term first given to the central and condensed portion of a comet, and thence to the central part of any appearance which is transparent towards the extremities and opaque towards the centre.

NUISANCE, or NUSANCE, is a term in English law derived immediately from the French *nuire*, and ultimately from the Latin *nocere*, "to hurt;" signifying an unlawful act or omission which occasions annoyance, damage, or inconvenience to others. Nuisances may consist of injurious acts done, or of omissions to perform duties prescribed by law, and are of two kinds, *common* or *public* nuisances, which affect all the queen's subjects, and *private* nuisances, which injure individuals. Instances of the former are, annoyances in highways, public bridges, or navigable rivers, which are produced by rendering the passage inconvenient or dangerous, either positively by actual destructions, or negatively by omitting to repair in cases where the law imposes the duty of repairing.

Noxious processes of trade or manufacture in towns are common nuisances by reason of the danger to the health of the inhabitants; and brothels, disorderly alehouses, gaming-houses, and unlicensed stage-plays are held to be common nuisances, both on account of the injury done by them to public morals and of the danger to the public peace by drawing together numbers of dissolute and irregular persons. The remedy for a public nuisance is by presentment or indictment; and the offender, upon conviction, may be punished by fine and imprisonment. It is said also that in the case of a positive obstruction to the free enjoyment of a public right, it may form part of the judgment that the offender shall remove the nuisance at his own cost; "and it seemeth to be reasonable," says Hawkins (book i. ch. 75, sect. 15), "that those who are convicted of any other common nuisance should also have the like judgment."

Private nuisances are annoyances which affect individuals only. Thus, if my neighbour builds a house so near to mine that he obstructs my ancient lights, or throws the water from his roof upon my house or land, this is a private nuisance; so also if he keeps noisome animals, or sets up an offensive trade or hazardous manufactory so near to my dwelling-house that the free enjoyment of my property is interrupted either by injury to my health or comfort, or the apprehension of danger. The remedy for a private nuisance is by action, in which damages may be recovered according to the injury sustained. Private nuisances, injurious to health, may be summarily suppressed on application to the magistrates, under the Nuisances Removal and Diseases Prevention Acts.

NULLITY OF MARRIAGE. [Marriage.]

NUMBER. The general considerations which this word would suggest cannot be treated independently of those required in treating the notion of ratio in general. As this will form a part of the subject of Proportion, we refer to that article as the continuation of the present one.

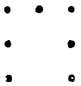
The notion of number is suggested by repetition or succession; and it is customary to call the actual things repeated, considered as a collection, a concrete number; while the notion formed from comparing the collection with one of the things collected is called an *abstract* number. This abstract number arises from repetition of objects, in which the attention is directed to the repetitions as repetitions, and not to the objects as distinguished from any other objects. It is therefore a number of times, not a number of things. [Multiplication.]

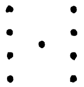
If we never numbered any things capable of division into parts like themselves, our notion of number would rest in what is now called *whole* number. If the intellect were taught to count by the beating of a clock, and never came in contact with any other magnitude except that of the intervals between the beats, it is difficult to see how the idea of fractions would be obtained. But when we come to put together continuous magnitudes, which might increase or decrease without any alteration except that of magnitude, such as lines, surfaces, &c., we then begin to see that the unit is purely arbitrary, considered as a magnitude, so that the consideration of smaller or larger units, and the reduction of processes from one unit to another, become necessary. Hence the doctrine of fractions, and finally that of Incommensurables.

The unit of magnitude and the unit of repetition are as distinct as concrete and abstract number. A given magnitude being chosen, we may fix our own ideas of other magnitudes and convey them to other persons by describing the repetitions of the given unit which will severally give the other magnitudes: but it is incorrect to say that in arithmetic we can perform all operations upon magnitudes represented by numbers; the operations are performed by our minds upon notions of repetition, not of magnitude. Any question of numbers arising out of geometry might, so far as the pure arithmetical processes are concerned, as well have the prototypes of its numbers in collections of beats of a clock or motions of the arm, as in repetitions of lengths or areas. It is not true that such simple successions would suggest as many problems as geometry or commercial business; but that is a distinct consideration.

Discussion formerly took place upon the question whether 1 represents a number; it being asserted that *number* must be *more than one.* The settlement of such a question depends upon convention entirely, and is very easy. In the common sense of the word neither 1 nor 2 are numbers: a number of men, or of pebbles, would suggest the idea of more than two; in fact the colloquial word *number* means indefinitely many; more than the eye can decide on without counting; *several,* that is to say, as many as require the *severing* which takes place in counting. With different persons this commencement of number, vulgarly speaking, may be different; all persons discern *three* without counting, and probably *four;* but it is certain that *five* must be severed by most persons, and *six* probably by all. Those who watch the progress of children can easily see that their scales of reckoning are successively one and more; one two, and more; one, two, three, and more.

In the common playing-cards we decide by forms, not by numbers; and were not the nine distinguished from the seven by the different positions of the odd spot, there would be continual mistakes.





In mathematical language, every numerical symbol is called number, including 0, 1, fractions, whole numbers, and even *infinity.*

The talent of easily combining and remembering numbers, or of calculation, is a perfectly distinct thing from that of mathematical invention, reasoning, or application; though the two are frequently confounded. Taking mathematicians of the highest order, some have been singularly gifted in this respect, some distinguished in neither way, and some more than commonly deficient.

A very deceptive mode of speaking is common with regard to numbers, which divides them into *cardinal* and *ordinal.* Thus *one, two, three, &c.,* are cardinal numbers, while *first, second, third, &c.,* are ordinal. The real distinction is that of numeral *nouns* and numeral *pronouns,* to the latter of which the term ordinal might properly be applied. That first, second, third, &c., are really pronouns is obvious if we consider that, so far as they go, *this, that,* and *the other* would supply their places. The so-called cardinal numbers denote collections; the ordinal numbers point out only the places of the several units of which a collection is composed. Even *one,* when its force is simply selective or distinctive, is a pronoun, as in "one or another." [ARITHMETIC; MAGNITUDE; PROPORTION; QUANTITY; UNIT.]

NUMBERING MACHINES differ from the apparatus described under MACHINES, CALCULATING, in being less complicated, and (for the most part) in performing operations of a less comprehensive character. Their work is that of numbering, or enumerating, and registering the results in some conspicuous way, with or without printing.

In the article MINT, a description is given of Colonel Harness's machine for weighing the blank pieces of gold which are to be stamped into sovereigns and half-sovereigns; and mention is made of another machine, invented by Mr. Cotton, employed at the Bank of England. As an example of one of those machines which calculate, or rather enumerate, by means of weighing, a few words of description may be given here. It is computed that 30,000 sovereigns pass over the Bank counter every day; and as it is necessary to ascertain whether these are of due weight, Mr. Cotton, when Governor of the Bank, in 1843, invented a machine to lessen the anxious labours of the bullion weighers, and caused it to be constructed by Mr. Napier. A pile of gold coins is placed in a small hopper at the top of the apparatus, and passes down a tube. A system of clockwork within the machine then seizes the lowest coin of the pile, and places it on a little platform, shaped like a quadrant, suspended over one end of a balanced beam. If the coin is of standard weight, a small tongue or slider advances and pushes it into one division of a till or box; if light, another tongue pushes it into a second division of the same till. No account is taken of those coins which are heavier than the standard; for such specimens are extremely rare. The tongues act at right angles to each other. While one coin is being thus weighed, a succeeding one is on its way from the hopper to the platform, and the moment the preceding coin is disposed of, another supplies its place. Each machine can weigh 10,000 sovereigns in six hours, separating all which are lower than the standard by a quantity so small as a fraction of a grain.

These machines, as well as Baron Leguier's for separating coins into three groups, according as they are true, light, or heavy; and Captain Smith's, for testing rupees at the Calcutta mint—perform their working by *weighing.* There is, however, a coin-*counting* machine employed at the California mint. The coins are thrown in sufficient quantity on a peculiar kind of tray, and shaken; they fall into oblong grooves, and all superfluous coins slide off when the tray is held sloping. In a very few seconds, one layer of coins covers the whole surface of the tray; and then the number is known to be 1000, neither more nor less.

Very ingenious machines are now made for combining numbering and dating with printing. Among many other kinds, the remarkable machine for numbering railway tickets was invented by the late Mr. Thomas Edmondson, while a station-clerk on the Newcastle and Carlisle railway. To facilitate the interchange of traffic between different companies, it is necessary that each passenger's ticket should be numbered, and Edmondson's machine is so contrived as to print the consecutive numbers of a whole series by a process nearly automatic. The colour of the cardboard is selected by the respective companies; and the general particulars, as to stations, class of train, and number of ticket, are printed at the establishment of the manufacturers; but the day of the month is printed in a few seconds, by a small machine in front of the booking-clerk. In the general printing, so done that one person can print 300 per minute, a pile of blank tickets is placed inside a receptacle, which also contains a little form of type relating to the names of the stations and the class of carriage. A ribbon saturated with ink, travelling over a wheel, is brought in contact with the type, which is instantly pressed down upon one of the blank tickets; the tickets are withdrawn one by one by a feeder from the *bottom* of the pile, and placed just in the proper spot for the inked type to act upon it. Every ticket receives a number, varying from 0 to 10,000. Raised numbers are engraved on the peripheries of two brass wheels, which revolve at different velocities; different numbers are presented for inking after each printing, in such a way that a series of tickets receive their numbers in proper order. It is not possible for the machine to print these numbers erroneously, so long as it remains in working order. The small upright apparatus on the booking-clerk's counter at a railway-station is the *dating-press.* It contains wheels, types, ink, and an inking ribbon; the clerk inserts one end of each ticket a little way between two cylinders, and draws it smartly away again instantly, with the date printed on it; all he has to do else is to change the date-types once a day, and to see occasionally that the ribbon is properly saturated.

Baranowsky's ticket printing, numbering, and registering machine; Lewthwaite's machine for numbering railway or pawnbrokers' tickets, or paging books, or printing any consecutive series of numbers; the machines invented by Church and Goddard, and by Messrs. Harrild, for printing and numbering railway tickets; and those invented by Mr. Shaw and Mr. Schlosinger, for paging ledgers and cheque-books—are all examples bearing a similarity to Edmondson's sufficiently close to render separate description unnecessary.

A remarkable process of printing a series of consecutive numbers is described under BANK-NOTE MANUFACTURE.

There is a great variety of instruments in which number or quantity is indicated by a dial, instead of by printing. Mr. Whiffen's apparatus records the number of times that a certain operation is performed; it was intended primarily to be applied to the trap-door of a ship's coal-weighing machine, to register the number of times that the door of the shoot has been opened for the discharge of coals; but a slight modification will enable it to register the filling of measures of grain, or the number of times that a porter or carrier has crossed a platform with goods; it comprises toothed-wheels, ratchets, and ratchet-wheels, a dial-plate, and index hands. Walker's *operameter* registers the amount of work done by certain machines. There is a shaft which may be connected with any one of such machines; the shaft rotates as fast as the machine, and gives motion to a train of wheelwork, with a dial-face and index hands; the hands thus become a measure and register of the amount of work done by the machine, so far as that work is denoted by revolutions of machinery. Something similar to this is the apparatus called a *counter,* often used in cotton factories to count or record the revolutions of particular parts of a machine. Scientific men now make large use of contrivances which measure and register certain phenomena with which they are concerned, such as heat, moisture, barometrical pressure, rain, wind, and tides—either by an index-hand moving round a dial, or by a pencil marking on a revolving cylinder of paper. Registers of time, space, and speed, are numerous and varied. All kinds of horological instruments belong, of course, to the first of these three groups. The *odometer* measures the length of roads and streets, and records the results on a dial suitably graduated. The *pedometer* counts and registers the number of steps taken by a person in walking, thereby measuring the distance walked if the steps are equal in length. Whishaw's *velocentimer* is intended to measure the velocity of a railway train, by showing how far an index-hand has moved during the passage of the train from one mile-post to another. Redier's *horographe* is intended to register the rate of speed between two stations, and the exact time at which the train arrives at each. Carey's measuring machine is a contrivance for recording the number of revolutions made by the wheel of a carriage, as denoted by the slow movement of an index-hand. The *turnstiles* at the pay places of bridges and exhibitions show, by an index-hand, the number of times that the stile has been turned to permit a passenger to pass through. Arèra's *pendule indicateur,* and many forms of *tell-tale,* are contrivances which test and register the vigilance of watchmen, guards, police, night porters, &c.: in most such machines, the man is expected to touch a particular part of the apparatus at certain intervals during the night; and if he fail to do this, a dial-face or other register tells a tale of his negligence, and of the period of the night when the negligence occurred. Numerous *indicators, monitors,* and *detectors,* have been proposed for use in omnibuses and cabs, either to measure the distance run, or to register the number of persons who have entered; in some of these, the passenger, when he enters or leaves the vehicle, steps on one end of a lever or spring, which works an index-hand; in others, the seat on which he sits has some such lever or spring beneath it; none of these machines, however, has come regularly into use.

A machine called the *timbre additioneur* combines the principles of both groups just described: namely, those which print consecutive numbers on tickets and pages, and those which register quantities on dial-faces. There are stamping dies, levers, inking-tables, wheel-work, and index-hands. With the full apparatus, the machine can number and stamp such documents as bills, letters, and share-certificates, and can record on the dial the number of stampings thus effected; while, with the stamping and inking apparatus removed, it may be made to count the passengers through a turnstile, or the revolutions of a coach-wheel, or the length of yarn spun by a machine, or that of cloth woven, or the revolutions of a fly-wheel or water-wheel.

NUMBERS, APPELLATIONS OF. Various names have been given to classes of numbers, each expressive of properties common to all in its class: they are pointed out in the following list:—

The whole scale, 1, 2, 3, &c., is called that of *natural* numbers; it is subdivided into the scale of *odd* numbers, 1, 3, 5, &c., and *even* numbers, 2, 4, 6, &c. These again are subdivided into *oddly odd* numbers, 3, 7, 11, &c.; *evenly odd* numbers, 1, 5, 9, &c.; *oddly even* numbers, 2, 6, 10, &c.; and *evenly even* numbers, 4, 8, 12, &c. These latter appellations are not in universal use, though they are very convenient. Thus with reference to division by two and by four, all numbers have names; but not with reference to any higher numbers. The expression of a number which divided by m leaves a remainder n (namely, $mx+n$, where x is a whole number) is so simple, that it is more easily written than described. When 0 is included in the list, it is considered as divisible without remainder by every number.

The division of numbers into *square* numbers, 1, 4, 9, 16, &c.; *cube* numbers, 1, 8, 27, 64, &c.; *fourth powers*, 1, 16, 81, 256, &c., and so on, may be carried to any extent.

A *prime* number is any one of the list 1, 2, 3, 5, 7, 11, 13, &c., no one of which is divisible by any number except unity and itself. A *composite* number is any one which is not prime.

A *figurate* number is any one out of the following series, the first excepted, which is only introduced as a basis.

	1	2	3	4	5	6 &c.
I.	1	3	6	10	15	21 &c.
II.	1	4	10	20	35	56 &c.
III.	1	5	15	35	70	126 &c.
IV.	1	6	21	56	126	252 &c.
V.	1	7	28	84	210	462 &c.
&c.				&c.		&c.

Each number is the sum of the numbers in the preceding row: thus 84 is the sum of 1, 6, 21, and 56, and 84 is the fourth number of the fifth order of figurate numbers. The nth number in the first order is $n\frac{n+1}{2}$, in the second order $n\frac{n+1}{2}\,\frac{n+2}{3}$ in the third $n\,\frac{n+1}{2}\,\frac{n+2}{3}\,\frac{n+3}{4}$ and so on.

Polygonal numbers, as their name imports [Polygon], may be subdivided into triangular, quadrangular, pentagonal, hexagonal, &c. To find the numbers which bear the name of an n-sided figure, form a series beginning with 1 and consisting of terms increasing in arithmetical progression, with a common difference $n-2$: and form the sums of terms of these series in the manner described. Thus for decagonal numbers, we have—

1	9	17	25	33	41 &c.
1	10	27	52	85	126 &c.

and the decagonal numbers are 1, 10, 27, &c. The mth number of the n-sided order of figures is

$$1+nm\frac{m-1}{2}-(m-1)^2$$

The following are some of the polygonal numbers:—

Triangular	1	3	6	10	15	21 &c.
Quadrangular	1	4	9	16	25	36 &c.
Pentagonal	1	5	12	22	35	51 &c.
Hexagonal	1	6	15	28	45	66 &c.

Pyramidal numbers are formed by summing the polygonal numbers; thus, to find pentagonally pyramidal numbers, take the pentagonal numbers—

1	5	12	22	35	51 &c.
1	6	18	40	75	126 &c.

Numbers were once considered as *abundant*, *perfect*, and *defective*. An abundant number was one in which the sum of all its divisors (unity included, but not itself) exceeds the number: thus 12 is an abundant number, because 1+2+3+4+6 is greater than 12. A perfect number was one in which the sum of all the divisors was equal to the number: thus 6 is 1+2+3, and is a perfect number, as is 28, or 1+2+4+7+14. A defective number was one in which the sum of the divisors is less than the number, as 10, in which 1+2+5 is less than 10. Whenever 2^n-1 is a prime number, then $2^{n-1}(2^n-1)$ is a perfect number; thus 2^7-1, or 127, is a prime number, whence $2^6(2^7-1)$, or 64 × 127, or 8128, is a perfect number.

Amicable numbers are those each of which is equal to the sum of all the divisors of the other. Such are

284 and 220
17296 and 18416
9363583 and 9437056

Other names have been invented descriptive of classes of numbers; but the preceding are those which most often occur in the past history of mathematics. With the exception of Square, Cube, Prime, *even*, and *odd*, the preceding appellatives rarely appear in modern works.

NUMBERS, OLD APPELLATIONS OF. The student of books verging on the middle ages will occasionally meet with some designations of numbers, or rather of the ratios of numbers to numbers, which may need explanation in a work of reference. Corresponding terms are found in the Greek writers, particularly in those on music, and they seem to have obtained universal currency in the middle ages by means of the work of Boethius on Arithmetic, which was a general object of study up to the middle of the 16th century.

These words illustrate a fault which has been avoided in our day by the adoption of the opposite extreme. The ancients often overloaded a subject with terms; the moderns cannot prepare them as fast as they want them. The higher analysis now abounds with objects of thought for which there are no names except complex algebraical symbols; the old arithmeticians strove to find names for all the varieties of numerical ratio.

In describing these words, we shall, where we can, use the English form of the Latin adjectives, to avoid overloading our article with Latin words: the adjectives accompany the word *numerus*, not *ratio*. The ratio of the greater integer number to the less was one of the following five, multiple, superparticular, superpartient, multiple superparticular, or multiple superpartient. The ratio of the less to the greater was either submultiple, subsuperparticular, subsuperpartient, multiple subsuperparticular, or multiple subsuperpartient.

The term multiple has been preserved, and its species, duple (double), triple, quadruple, quintuple, &c. Thus 10 to 2 is a multiple ratio, namely quintuple: that of 2 to 10 is submultiple, namely subquintuple.

Superparticular ratio (part, that is, aliquot part, over) is when the greater contains the less and a submultiple of the less: its varieties are sescuple or sesquialter, sesquitertius, sesquiquartus, &c. Thus the following ratios are superparticular: 15 to 10, which is sesquialter; 16 to 12, which is sesquitertius; 15 to 12, sesquiquartus; and so on. But the ratio of 12 to 15 is subsuperparticular, namely subsesquiquartus. One of these names is still preserved in our language, in the *sesquialter* stop of an organ. The ratio of 3 to 2 (a sesquialter ratio) is that of the length of a pipe to the length of a pipe which sounds the fifth above the note of the first. Accordingly when a stop was made to sound with the ordinary stop, but a fifth above it, the name sesquialter was given to the stop which gave the higher note.

Superpartient ratio, according to Boethius, is that in which the major term is twice the minor all but an aliquot part. Its varieties are superbipartient (ratio of 5 to 3), supertripartient (ratio of 7 to 4), superquadripartient (of 9 to 5), and so on. Thus the ratio of one and *four*-fifths to one is super-*quadri*-partient. According to Boethius, then, the intermediate ratios of one and two-fifths and one and three-fifths to one have no names. Some of his followers extend the name of superpartient to these, and some would invent the adjectives superbiquintus and supertriquintus to signify them; other used superbipartiens quintas and supertripartiens quintas. Multiple superparticular and multiple superpartient ratios have in the major term a multiple of the minor together with the fraction which gives the remaining adjectives. Thus, the ratio of $7\frac{1}{4}$ to 1 is multiple superparticular, being septuplus sesquiquartus; and $7\frac{3}{4}$ to 1 is multiple superpartient, being septuplus supertripartiens. The preposition *sub* serves as before, prefixed to *super*, to denote the inverse ratios. The reader may fancy for himself, if he can, the beauty of a treatise in which the ratio of 4 to 11 is expressed by *duplus subsupertripartiens*. Not that the writers of these works were ignorant of more simple phrases; and we remember one place in which the example of Aristotle is brought forward to show that it would not be wrong to use them.

Of means, or *medicties*, Boethius discusses ten, to which Jordanus added an eleventh. The first three bear the names which have descended to us, arithmetic, geometric, and harmonic; and all are as follow. Let a, b, c, be three numbers, of which a is the greatest and c the least.

1 a—b : b—c : : a : a
2 a—b : b—c : : a : b
3 a—b : b—c : : a : c
4 b—c : a—b : : a : c
5 b—c : a—b : : b : c
6 b—c : a—b : : a : b
7 a—c : b—c : : a : c
8 a—c : a—b : : a : a
9 a—c : b—c : : b : c
10 a—c : a—b : : b : c
11 a—c : a—b : : a : b

The works of Boethius and his followers consist in dissertations on what would now be called the most obvious properties of the ratios of numbers, enriched with comments of every species, from numerical to theological. It is not right that they should be utterly lost sight of, for they form a dark background on which the merits of Sacrobosco, Bradwardine, Regiomontanus, and afterwards Tonstall and Recorde, are very distinctly seen.

NUMBERS, FIGURATE and POLYGONAL. [NUMBERS, APPELLATIONS OF.]

NUMBERS OF BERNOULLI. This name is given to certain numbers (we here see the mathematical use of the word, for they are all fractions) first used by James Bernoulli, in his 'Ars Conjectandi.' They are in fact (though not so considered by Bernoulli) the co-efficients of the divided powers of x in $1 : (\epsilon^x - 1)$. We should hardly have given them a place here, as our list of such ultimate references in mathematics is by no means complete, if it were not that they only appear to a sufficient extent in one English work that we know of (Peacock's Examples). Let

$$\frac{1}{\epsilon^x - 1} = \frac{1}{x} - \frac{1}{2} + \frac{B_1 x}{2} - \frac{B_3 x^3}{2.3} + \ldots.$$

a form which it is shown to take. Then B_1, B_3, B_5, &c., are what are called the numbers of Bernoulli, and the following list will show twenty-five of them, the first column being the index of B, the second the numerator of the fraction, and the third its denominator. As far as B_{29} these are taken from Euler's Differential Calculus, all the rest (and the logarithms) from Grunert's Supplement to Klugel, which professes to take the additional numbers from a work of H. A. Rothes, and the logarithms from Eytelwein's work on the higher analysis:—

No.	Numerator.	Denominator.
1	1	6
3	1	30
5	1	42
7	1	30
9	5	66
11	691	2730
13	7	6
15	3617	510
17	43867	798
19	174611	330
21	854513	138
23	236364091	2730
25	8553103	6
27	23749461029	870
29	8615841276005	14322
31	7709321041217	510
33	2577687858367	6
35	26315271553053477373	1919190
37	2929993913841559	6
39	261082718496449122051	13530
41	1520097643918070802691	1806
43	27833269579301024235023	690
45	596451111593912163277961	282
47	5609403368997817686249127547	46410
49	495057205241079648212477525	66

Thus the coefficient of $x^{15} : 1.2.3\ldots15$ in the development of $1 : (\epsilon^x - 1)$ is $3617 : 510$, or B_{15}. The logarithms of the first eighteen numbers are as follows:—

No.	Logarithm.
1	0·2218487496 − 1
3	0·5228787453 − 2
5	0·3767507096 − 2
7	0·5228787453 − 2
9	0·8794260688 − 2
11	0·4033154004 − 1
13	0·0669467896
15	0·8507783387
17	1·7401350433
19	2·7235576597
21	3·7918359878
23	4·9374188514
25	6·1539724516
27	7·4361345055
29	8·7792940212
31	10·1794459554
33	11·6330790754
35	13·1370898829

The higher numbers may be approximately verified by the following rule. Let π be the ratio of the circumference of a circle to its diameter; then

$$B_{2x-1} = 2\frac{1.2.3\ldots\ldots2x-1.2x}{(2\pi)^{2x}} \text{ nearly.}$$

We shall have some occasion to point out the uses of the numbers of Bernoulli in the article SERIES. The theory of these numbers will be found in Peacock's translation of Lacroix, Euler's 'Differential Calculus,' Lacroix's 'Different Calculus,' 3 vols., and in a very elaborate article ('Bernoullische Zahlen') in the work of Grunert already cited.

NUMBERS, THEORY OF. The theory of numbers is in fact the science of whole or integer numbers, and its most general problem is: "Given any equation whatsoever involving two or more unknown quantities, or any number of equations between a greater number of unknown quantities, to determine every possible solution in which the values of the unknown letters are whole numbers." It may also be considered that the science extends to the determination of all solutions which contain nothing but rational or commensurable fractions, all surd quantities or incommensurables being excluded. If, for example, the equation $x^2 + y^2 = 1000$ were to be solved, x and y being whole numbers or rational fractions, let the rational fractions reduced to a common denominator be $p : z$ and $q : z$; then the equation becomes $p^2 + q^2 = 1000\, z^2$; and if all possible whole values of p, q, and z be found, all the fractional solutions of the former equation can be exhibited.

Connected with the science before us is a very large quantity of properties of numbers, of which it must be said that they can be proved easily enough, but cannot be explained. Usually, in retracing the steps of an algebraical demonstration, we can easily connect the result with common and self-evident notions, which seem both to justify the conclusion, to render it natural, and destroy much of the curiosity, and even interest, with which it is looked at by a person used to algebra, who hears of the conclusion for the first time. In the theory of numbers it seems to us that the curious character of the conclusions is not so much lessened by the demonstrations, and perhaps this may be the reason why the science becomes a sort of passion, as Legendre remarks, with most of those who take it up. The instances given by the writer just cited, in his preface, will show the sort of properties which we speak of. If c be any prime number, and N any other number not divisible by c, then $N^{c-1} - 1$ is always divisible by c. Then $2^6 - 1$, or 63, is divisible by 7. Again, if any prime number divided by 4 leave a remainder 1, it is the sum of two square numbers: thus 13 is the sum of 9 and 4, 17 of 16 and 1, 29 of 25 and 4, &c.

The theory of numbers is not of much immediate practical utility in the applications of mathematics, which generally involve continuously increasing magnitude, and in which therefore the introduction of whole numbers is matter of convenience, and not of necessity. Again, the data of such applications are usually only approximate, so that an answer in whole numbers, should such a thing occur, is not exact, and possesses no particular interest. Hence this theory is little studied by a very large class of mathematicians, among whom it is not uncommon to meet with a person deeply versed in the higher analysis, who does not even know the principal results obtained by Gauss or Legendre. The subject is, in fact, an isolated part of mathematics, which may be taken up or not, at the choice of the student. It may possibly at some future time be connected with ordinary analysis, that is to say, the determination of the *integer* solutions of a set of equations may not be so distinct a thing from that of a mere solution, integer or not, as it is at present. In fact, a hint given by M. Libri, in a tract presently to be cited, does give completely the means of assimilating the expression of a problem in this theory to that of one in ordinary analysis. Suppose, for example, it is required to solve in whole numbers the equation $x^2 + y^2 = x^3$. Let π represent two right angles; then it is well known that $\sin \pi x = 0$ when x is a whole number, and never else; so that "required a solution of $x^2 + y^2 = x^3$ in whole numbers" is precisely the same problem as "required any solution of the three equations $x^2 + y^2 = x^3$, $\sin \pi x = 0$, $\sin \pi y = 0$."

The earliest consideration of the theory of numbers may have been made in India [VIGA GANITA, in BIOG. DIV.]; but the earliest treatise is probably that of Diophantus, which consists of nothing else but problems of this science, insomuch that the theory itself has been sometimes called the Diophantine analysis. The subject then rested, without making any progress, until the time of Bachet de Meziriac and Fermat, the editor and commentator of Diophantus. The subject rested again until the time of the man who literally left no part whatever of mathematics unaugmented, Euler. After him, Lagrange, Legendre, and Gauss applied themselves contemporaneously to this theory. The works of the two latter are the separate treatises on this particular science, in which the advanced mathematical student must look to know its present state. Various Memoirs of MM. Cauchy and Libri may also be mentioned; one in particular by the latter (in the 'Mémoires de Mathématique et de Physique,' vol. i., Florence, 1829), in which the subject is made to have more resemblance than usual to ordinary analysis. An elementary treatise on the theory of numbers, suited to the present state of the subject, is much wanted. The only one in English, that of Barlow, was published in 1811: it can be well recommended for all that it includes.

The 'Disquisitiones Arithmeticæ' of Gauss (Brunswick, 1801) were translated into French by M. Poullet-Delisle (Paris, 1807). The 'Théorie des Nombres' of Legendre (third edition, Paris, 1830) has the advantage of coming later than that of Gauss (which itself came after the first edition of Legendre's), and of using methods and notations which are more familiar to the mathematician. Both are works of great originality: that of the German is condensed, and full of historical information; that of the Frenchman easier to follow, but like most French works, deficient in precise historical reference. It is not a little singular that the two great writers on this subject should have been the men who, independently of each other, introduced the method of LEAST SQUARES.

The beginner in algebra may obtain some command over equations of a simple character, not exceeding the second or third degree, by a method which is, we believe, due to Playfair, or which, at least, is published in the collection of his works. Let the equation be, for instance, $ay^2+bxy+x^2=z^2$, in which x, y, and z are to be whole numbers. Throw the equation into a form which admits of both sides being reducible into factors; for instance,

$$y(ay+bx)=(z-x)\,(z+x).$$

If then $z-x=v\,y$, we have $z+x=(a\,y+b\,x):v$, which equations give

$$x=\frac{(a-v^2)\,z}{a-b\,v+v^2}\qquad y=\frac{(2v-b)z}{a-b\,v+v^2}$$

Assuming v at pleasure, z may be easily taken so as to make both x and y whole numbers; and the same method will succeed in many equations.

Euclid's geometry, assuming only the use of his three celebrated postulates, enables him, a linear unit being given, to construct the length represented by any algebraical expression which involves only additions, subtractions, multiplications, divisions, extraction of the square root, or combinations of all these. But a cube or fifth root is beyond the power of the system. Again, from the theory of equations it is soon made obvious that the solution of the equation $x^n-1=0$, and the division of a circle into n equal parts, are one and the same problem. One solution of the preceding is $x=\cos\,\theta+\sqrt{-1}.\,\sin\,\theta$, where θ is the nth part of four right angles. [ROOT.] Euclid, in his fourth book, shows how to cut a circle into three, four, five, and fifteen equal parts; and analysis shows that the sines and cosines of the angles so involved can be obtained by formulæ which involve no roots except the square. But except into halves, thirds, fifths, or fifteenths, or parts obtainable from these by one or more bisections, Euclid was not able to cut a circle into equal parts.

So the matter rested for about 2000 years, until Gauss, in his 'Disquisitiones Arithmeticæ' (1801), not only pointed out how to extend Euclid's conclusions, but also in a manner how to account for them. The statement of his results, even without demonstration, is instructive to the learner, and we shall give it accordingly: referring for the demonstration to the works of Gauss or Legendre, or to Murphy's 'Theory of Equations.'

The expression $a+\sqrt{b}$, a and b being rational, is the solution of a quadratic equation with rational co-efficients. But if a and b themselves have the form $c+\sqrt{d}$, in which c and d have themselves the same form, and so on; then $a+\sqrt{b}$ is the solution of a quadratic equation in which the coefficients are themselves the solutions of quadratic equations, and so on. Consequently, any equation, the root of which is capable of construction by Euclid's postulates, must be reducible to a system of quadratics; and the converse. Now if n be a prime number, $n-1$ is an even number, and therefore has factors. Let its prime factors be 2, a, b, c, &c., and let them severally enter p, q, r, s, &c., times: so that

$$n-1=2^p\,a^q\,b^r\,c^s\ \ldots.$$

Gauss succeeded in showing that when n is a prime number, the solution of the equation $x^n-1=0$, can be made to depend upon the solution of p equations of the second degree, q of the ath degree, r of the bth degree, and so on. Consequently, whenever 2 is the only prime factor of $n-1$, or when $n-1=2^p$, n being prime, or when 2^p+1 is a prime number, the solution of x^n-1 is reducible to that of p quadratic equations, and the division of the circle into n equal parts can be accomplished by Euclid's geometry. And further, it is easily demonstrated that 2^p+1 can never be a prime number, except when p itself is a power of 2 (2^0 included) though 2^p+1 is not then always prime. Nor has it been shown that other divisions are impossible: Gauss's theorem merely points out cases in which the thing can be done, without pronouncing the exclusion of others. Gauss, indeed, does assert that he can demonstrate all other cases to be impossible to be constructed by geometry, that is, reducible to quadratic equations: and the thing is highly probable. If we now construct the series 2^1+1, 2^2+1, 2^4+1, 2^8+1, &c., among which all our chances lie, we have 3, 5, 17, 257, 65537, 4294967297, &c. The first five are prime numbers: Euclid has disposed of the two first divisions; Gauss has added that a circle can be geometrically divided into 17, 257, and 65537 equal parts. But 4294967297 is not a prime number, being divisible by 641.

NUMBERS, THE BOOK OF, one of the books of the Pentateuch. In Hebrew it has two titles, וַיְדַבֵּר, *and he spake*, which is the first word of the book, and בְּמִדְבַּר, *in the desert*, which is the fifth word in the first verse, and which applies to the whole book, inasmuch as the events which it records took place in the desert. Its title in the Septuagint is Ἀριθμοί, Numbers, because it contains the censuses of the people of Israel (chaps. i.-iii., and xxvi.).

The first four chapters of this book consist of separate accounts of commands given by God to Moses, while the Israelites were encamped at the foot of Sinai, respecting the census and the classification of the people, and the duties of the priests and Levites. The succeeding chapters (v.—x. 10) contain various laws, most of which are additions to those before given in the books of Exodus and Leviticus; and the rest of the book is occupied with the narrative of the journeys of the Israelites, from the time of their leaving Sinai to their second arrival at the Jordan, and their encampment in the plains of Moab. The time over which the book extends is from the first day of the second month of the second year after the departure from Egypt, to the first day of the eleventh month of the fortieth year of the same epoch. This part of the book also contains various enactments.

We learn from the last verse of the last chapter that this book was written by Moses "in the plains of Moab by Jordan near Jericho," and consequently just before his death. Vater has attempted to show that it is composed of short narratives written by different persons (vol. iii., p. 452, &c.), and De Wette adduces several passages which appear to disagree with each other, and with the parallel passages in the book of Exodus ('Lehrbuch d. Hist. Krit. Einleitung in d. A. T.'); but the more carefully the facts and allusions contained in it are examined, the more satisfactorily they confirm the belief that it, as well as the other books of the Pentateuch, was the production of Moses, and its genuineness rests upon the same points of evidence as to its origin and its historical truth as the other books. Even De Wette admits that parts of it belong to the Mosaical age.

This book is quoted or referred to in the New Testament (compare Numb. xx. 11 with 1 Cor. x. 4, and Numb. xxi. with John iii. 14). The passage in chap. xxiv. 17–19, is generally understood as a prediction of the Messiah.

(Rosenmüller's *Scholia in Vet. Test.*; the *Introductions* of Eichhorn, Jahn, De Wette, and Horne; Graves's and Vater's *Commentaries on the Pentateuch.*)

NUMERAL CHARACTERS. There are three simple and obvious modes of constructing symbols of number. 1. By arbitrary invention. 2. By the choice of letters of the alphabet. 3. By a system of repetitions of a single unit, as I, II, III, IIII, &c., with marks of abbreviation. Some may doubt whether the first and third were ever really employed; but it is not known that we can assign to the Indian numerals any other origin than the first, and the third explains the Roman system with a degree of consistency which is most extraordinary, if it be only accidental coincidence.

Distinct numeral characters are found to have existed or to exist among the Chinese, Indians, and Arabs, &c., Phœnicians, Palmyrenes, Hebrews, Egyptians, Greeks, and Romans; and others are given as in ancient use among the Mexicans. We shall here confine ourselves to the simplest explanation of those systems which will be wanted by the student of ancient literature. Of these, as it should seem, the Indian system may belong (though it may be doubted) to the first class; the Hebrew and the common Greek system to the second; the Roman, Phœnician, Palmyrene, ancient Greek, Egyptian, and Chinese, to the third class.

The system received from the Hindus through the Arabs, and now adopted throughout Europe, has been gradually much altered in the forms of the symbols. The symbols we now use, especially in their old manuscript forms, 1, 2, 3, 4, 8, may be explained with reasonable probability upon the third system; but not 5, 6, 7, 9. [ARITHMETIC.]

The Hebrews used the letters of their own alphabet, giving the finals a separate and particular value, as follows:—

Letter	א	ב	ג	ד	ה	ו	ז	ח	ט	י
Numeral Signification	1	2	3	4	5	6	7	8	9	10
	כ	ל	מ	נ	ס	ע	פ	צ	ק	
	20	30	40	50	60	70	80	90	100	
	ר	ש	ת	ך	ם	ן	ף	ץ		
	200	300	400	500	600	700	800	900		

The use of the final letters as signifying numbers is of newer date than the rest; the old system required the junction of subordinate numbers to express 500, 600, &c. Numbers not expressed above were made by juxta-position of letters denoting other numbers, according to a decimal subdivision, as among the Greeks; the only exception being 15, which, as 10+5 or יה made a word signifying the Creator, they wrote as 9+6, or טו. In a language like the Hebrew it would be impossible to prevent every combination of numbers from also standing for a word or words; and the Oriental nations accordingly have frequently expressed dates by sentences. Thus "Hooshung Shah is no more," rendered into Persian, expresses, in the numeral force of the letters, the year 837 of the Hegira, the date of the death of that prince.

The Greeks, in some enumerations, have three distinct methods of expressing numbers; but the first of them, which consists in the use of the letters of the alphabet to denote the successive books of a work, as in the 'Iliad,' is as much a method of naming as of counting. Something more to the point is the old system which occurs on inscriptions, in which the unit is represented by a single mark, five by Π (the initial of ΠΕΝΤΕ), ten by Δ (that of ΔΕΚΑ), and 100 by Η (that of ΗΕΚΑΤΟΝ). And in all cases five of any symbol are written by inclosing the symbol in Π: thus $|\overline{\Delta}|$ is five tens and $|\overline{\text{H}}|$ is five hundreds. Thus 879 is $|\overline{\text{H}}|$ ΗΗΗ $|\overline{\Delta}|$ ΔΔΠΙΙΙΙ. This ancient Greek method, as found on inscriptions (which, according to Heilbronner, is alluded to in a written work by Herodian only), is supposed to be as old as the time of Solon. The Egyptian hieroglyphic system is on the same principle, but without abbreviations; the symbol of ten resembling that just given for five.

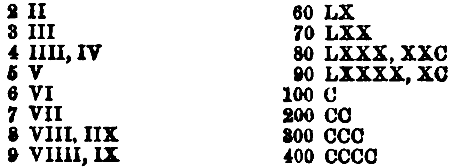
In describing the later Greek notation, we leave out of view the extensions made by the mathematicians, the principle of which is described in ARITHMETIC. It appears most distinctly that the system was made either at a time when the Greek alphabet was in possession of more letters than it permanently retained, or that it was introduced into Greece by communication with some nation (the Phœnician, perhaps) which had some additional letters. The *Vau* of the Hebrew and Phœnician, which stands for six, and is wanting in the Greek alphabet, appears in the Greek numeral system under the name of *ἐπίσημον βαῦ*, and is expressed by a symbol resembling ϛ, not very unlike the Vau turned the other way. The Koph and Tsaddi appear under the names of *ἐπίσημον κοππὰ* and *ἐπίσημον σανπι*, with symbols expressed in our types by ϟ and ; but the former is one behind its place in numeral signification, being 90 among the Greeks and 100 in the East: the latter takes the same numeral place as the final Tsaddi in the Hebrew system. The word *air* will be a useful guide to the letters beginning the several scales, as follows:—

Letter	α	β	γ	δ	ε	ϛ	ζ	η	θ
Numeral Signification	1	2	3	4	5	6	7	8	9
	ι	κ	λ	μ	ν	ξ	ο	π	ϟ
	10	20	30	40	50	60	70	80	90
	ρ	σ	τ	υ	φ	χ	ψ	ω	ϡ
	100	200	300	400	500	600	700	800	900
	α,	β,	γ,	δ,	ε,	ϛ,	ζ,	η,	θ,
	1000	2000	3000	4000	5000	6000	7000	8000	9000

The Roman notation, including all the varieties which occur in printed works, is as follows:—

1	I
2	II
3	III
4	IIII, IV
5	V
6	VI
7	VII
8	VIII, IIX
9	VIIII, IX
10	X
11	XI
12	XII
13	XIII, XIIV
14	XIIII, XIV
15	XV
16	XVI
17	XVII
18	XVIII, XIIX
19	XVIIII, XIX
20	XX
30	XXX
40	XXXX, XL
50	L
60	LX
70	LXX
80	LXXX, XXC
90	LXXXX, XC
100	C
200	CC
300	CCC
400	CCCC
500	D, IↃ
600	DC, IↃC
700	DCC, IↃCC
800	DCCC, IↃCCC
900	DCCCC, IↃCCCC
1000	CIↃ, M, ∞, I
2000	CIↃCIↃ, IICIC, IIM
5000	IↃↃ, V
10000	CCIↃↃ
50000	IↃↃↃ
100000	CCCIↃↃↃ
1000000	CCCCIↃↃↃↃ

The grammarian Priscian would have it that I denoted unity, because the Greek word *μια*, with *μ* cut off, has *ι* for its first letter; that V is five, as being the fifth vowel, and X ten, as being the tenth consonant, of the Greek alphabet. Any explanation of this system which endeavours at an alphabetical deduction must, as far as has yet been seen, fail entirely in giving a probable origin. The following scheme, however, contains suggestions of some antiquity, and certainly, as before remarked, is either a true explanation or a most extraordinary coincidence. The account of it was revived in our day by Leslie, in an article in the 'Edinburgh Review,' and afterwards in his 'Philosophy of Arithmetic.' But it may be found almost entire in the 'Cursus Mathematicus' (1690, vol. i., p. 28) of Dechales, who gives it as the opinion of several of his time. And the earliest hints (by no means complete, and mixed with some absurdities) which we have found are in the 'De Numeris Libri Duo' of John Noviomagus, Paris, 1539, 8vo.



Imagine a person used to decimal counting by means of the fingers having recourse to simple counting by making a mark for each successive unit, as in *a*, *b*, *c*, &c. At ten he might be expected to make some symbol that his *handful* was completed, and the drawing a mark through the whole ten unit symbols, as at *e*, would do very well. This he might abbreviate, as at *f*, retaining only the symbol of a unit and that of the line drawn across. The handful of tens, or one hundred, might be represented by retaining only the unit symbol and two ligatures, namely, that of the tens and that which made all the ten tens into one symbol, as at *g*. The ten hundreds would require a unit with three ligatures, or four strokes altogether, which, if they were written without taken the pen off, might be made as at *h*, which might degenerate into *k*, and finally into *l*. Again, by cutting *l* into two halves, we have *m* or *n*, which might suggest themselves as proper representatives of half a thousand, or five hundred. Similarly, bisection of *f* and *g*, or of *o* and *q*, would suggest *p* and *r* as proper symbols for the halves of ten and one hundred. The symbol *a* has a resemblance to I, *f* to X, *g* to C, *h* to M. *m* to D, *p* to V, and *r* to L.

We cannot find any precise information upon the time of the commencement of the principle of local value which prevails to a certain extent throughout the Roman system,—namely, that a smaller symbol before a larger one, in numbers less than one hundred, denotes a subtraction, after it an addition. This principle does not appear in the Phœnician or Palmyrene notations, which otherwise much resemble the Roman in their principle of notation, though they approximate to pure vicenary scales, both adopting distinct symbols for twenty.

The Chinese use three systems: the first, not very simple, and ancient; the second, intentionally complicated, and employing symbols of words to denote numbers, is introduced in deeds and other instruments, to render alteration difficult; the third, a simplification of the first, supposed to have been made by the Jesuit missionaries.

For further information on the subject of this article, with abundant references, see the article 'Arithmetic' in the 'Enclopædia Metropolitana,' by Dr. Peacock.

NUMERATION is a term generally applied to the art of representing numbers by distinct names and symbols, a sense in which the word is used by the oldest writers. Every treatise on arithmetic must necessarily begin with something on this art of counting and representing the results of counting, on the goodness of which, slight and easy as any method may appear to which we have been habituated from childhood, the progress of the arts of life, to say nothing of the mathematical sciences, is in no slight degree dependent. The time is gone by for a formal eulogy upon the benefits of any fundamental method of expression; we will therefore content ourselves with quoting a part of that which is found in the first English work on arithmetic, Robert Recorde's 'Grounde of Artes' (1540). We quote this also because it is an instance (the only one we ever met with in a mathematical work) of the species of doggrel comic verse afterwards in use on the stage (see the 'Comedy of Errors'), which has a sort of measure and rhyme, though printed in the form of simple prose in the work from which we cite (we put the syllables which are meant to rhyme in italics):—"*Master*. Wherefore in all great workes are clerks so much desi*red*? Wherefore are auditors so richly *fed*? What causeth geometricians so highly to be *inhaunsed*? Why are astronomers so greatly *advanced*? Because that by number such things they *find*, which else would far excel man's *mind*. . . . . *Master*. Exclude number, and answer to this question: How many years old are you? *Scholar*. Mum. *Master*. So that if number want, you answer all by *mummes*? How many miles to London? *Scholar*. A poak full of *plums*. . . . . *Master*. If number be lacking, it maketh men *dumb*, so that to most questions they must answer *mum*. *Scholar*. This is the cause, sir, that I judged it so *vile*, because it is so common in talking every *while*; for plenty is not dainty, as the common saying is. *Master*. No; nor store is no sore, perceive you *this*? The more common that the thing is being needfully *required*, the better is the thing and the more to be *desired*. But in numbring, as some of it is light and *plain*, so the most part is difficult and not easie to *attain*."

The earliest method of signifying a large number must have been such a one as the scholar uses above, when he designates a large number of miles as a "poak full of plums," namely, the similitude of some visible or well-known collection of units. The fingers of the hand, or of both hands, or the united number of fingers and toes furnished natural collections of reference on which the various quinary, decimal, and vicenary scales in existence have proceeded. The transition from counting by tens to counting by dozens might have been caused by the facility of subdivision which the number twelve possesses, though we rather doubt this explanation, at least unless we assume that the division of the Roman *As* into twelve *unciæ* is to be explained on the same principle. From this we think came the method of reckoning by dozens to be introduced throughout Europe, as would that by thirteens, if the Roman coin or weight had been so divided.

Our present numerative system is stated by writers to employ the words unit, ten, hundred, thousand, million, billion, trillion, quadrillion, quintillion, sextillion, septillion, octillion, nonillion, &c. But the greater part of this is pure statement; for the terms billion, trillion, &c., though defined by arithmetical writers, have never found their way into common use, the want of such large numbers having never been experienced. The French indeed have naturalised the term *milliard*, meaning one thousand millions, in matters of public debt and revenue, which only shows how little the term *billion* has been used among them, since, according to their writers, the milliard and billion are the same things. Tonstal expressly says, that in his time (Henry VIII.) the common reckoning from millions was made by millions of millions, &c., and the word *millie* is noted as a vulgarism by him (neither is it among the recognised barbarisms of Ducange). Recorde uses nothing more than millions repeated; so that it seems the billions and higher denominations were never anything but a fancy of arithmetical writers, conceived after the time when elementary works ceased to be written in Latin. The probability of this is increased by their meaning different things in different countries: with us the billion is a million of millions, a trillion is a million of billions, and each denomination is a million of times the one preceding. With the French and the other Continental nations (except some of the older writers, at least, among the Italians), the billion is a thousand millions, and each denomination is a thousand times the preceding. According to English writers, the number 1,234567,891234,567891 is one trillion, 234567 billions, 891234 millions, and 567891; according to the French writers, it is one quintillion, 234 quadrillions, 567 trillions, 891 billions, 234 millions, 567 thousands, and 891. For common purposes, the denominations higher than a million may be abandoned, it being remembered that all the figures on the left, after six are taken off on the right, are so many millions, and all above twelve figures so many millions of millions. In writing, round numbers of millions should be written as such; thus, 638 millions, not 638,000,000: in computation it is of course a different thing. Some authors seem to think it very scientific to parade ciphers, sometimes by the dozen; and so it is, no doubt, since it shows they know how many ciphers go to a million or a million of millions; but no reader likes to stop and examine 000,000,000,000, when the words "million of millions" would have done equally well.

The decimal system, made complete, supposes a point always to be placed at the end of the units, to separate them from the fractions which may follow. When there are no fractions, the point is useless, as in 675· or 675·000, which is 675. The numbers on the right of the point, successively denoting tenths, hundredths, thousandths, &c. of a unit [Fractions], are in denominations which have not received distinct names. The modern French call them decimes, centimes, &c.; and the attempt has before now been made (see Wybard's 'Tactometria' 1650) to introduce centesms, millesms, &c. into English, but with no success.

The principle of *local value* [Arithmetic], which distinguishes our system of numeration from that of the Greeks and Romans, is applicable to any system, whether decimal or not. If 10 stands for *ten*, that is, if its units in the second column are ten times in value those of the first column, nine numeral symbols besides the cipher are requisite; but if 10 had signified fifteen, it would have been necessary to have fourteen distinct symbols of number besides the cipher, since 10, 11, &c. now stand for sixteen, seventeen, &c. In such an explanation, the frame-work of our numerical language (being decimal) is not well calculated to give an easy comprehension of the change: we should rather invent a word for fifteen, or five and ten, say A; whence A-one, A-two, &c. would be the spoken sounds answering to what we now call sixteen, seventeen, &c.; while ten, eleven, twelve, thirteen, and fourteen would require new names not connected in etymology with *ten*.

The method of reducing a number, decimally expressed, to another in which the *radix* or base of the system (as ten is that of the common one), is *a*, is as follows: divide the number successively by *a*, expressed in the decimal system; the remainders give the units, *a*s, *aa*s, &c. of the new expression. Thus if 12376 is to be expressed in the *quinary* system, whose base is 5, we should have the following process:—

	Rem.
5)12376	
5)2475	1
5)495	0
5)99	0
5)19	4
5)3	4
0	3

Number required,
344001.

Decimal.

$$\begin{array}{rcr} 3\times5^5 & = & 9375 \\ 4\times5^4 & = & 2500 \\ 4\times5^3 & = & 500 \\ 1 & = & 1 \\ \hline & & 12376 \end{array}$$

This exhibits both the reduction to the quinary system and the restitution of the decimal expression; but if the number had been given in the quinary system, it might have been reduced to the decimal system by the same rule, the new base ten being, in the old or quinary system, represented by 20, and the rule of division being performed by the use of five in the same manner as ten is used in the decimal system.

	Rem.
20)344001	
20)14422	11 or 6
20)443	12 or 7
20)22	3
20)1	2
0	1

Number required,
12376.

$$\begin{array}{rcr} \text{Decimal.} & & \text{Quinary.} \\ 1\times(10)^4 & = & 310000 \\ 2\times(10)^3 & = & 31000 \\ 3\times(10)^2 & = & 2200 \\ 7\times10 & = & 240 \\ 6 & = & 11 \\ \hline & & 344001 \end{array}$$

The quinary being supposed the old system, as soon as we come to the remainder 11, we have to invent a new symbol (say 6), since 11, in the *new* system, is to stand for eleven. For further examples, see the 'Library of Useful Knowledge: Treatise on the study of Mathematics.'

In teaching the elements of numeration by the abacus [Abacus], it is desirable that exercise should be given in several different systems, were it only to prevent the formation of that impression which so many students long retain, that the decimal system is natural and necessary. The want of words for the denominations will be the only difficulty; this may be got over by using the letters A, B, C, &c., to represent them. Thus if the system be quinary, A counts as one ball on the second row or five on the first, B as one ball on the third row, five on the second, or twenty-five on the first, and so on. All the balls on the second row may be marked A, those on the third B, &c.

NUMERATOR (or numberer), the part of a fraction which states how many of the aliquot parts of a unit are taken, such as are described by the denominator. Thus $\frac{3}{7}$ being three, not of units, but of sevenths of a unit, 3 is the numerator.

NUMERICAL, as opposed to literal, in algebra, applies to an expression in which the coefficients of a letter are all numbers, and not letters. As opposed to algebraical, it applies to the magnitude of a quantity, considered independently of its sign. Thus -7 is said to be numerically greater than -5, though algebraically less. [Nothing.]

NUMERICAL DIFFERENCE. (Logic.) Down to our own time, logicians have distinguished one individual as differing *numerically* from another, when both belong to the same species: thus one horse is said to differ numerically from another. The idiom has never found its way into common language, though given in our old dictionaries. Nor is this to be wondered at, for number in English is multitude; and two regiments may differ numerically, but two men cannot.

The wrong use of the English adjective arises from the Greek word *ἀριθμός*, which is used for the result of counting, being supposed to signify the multitude counted. This it did only in the sense in which *summa* (sum) came to signify multitude in English: thus 10 is a *sum*, of which the *unitas summa* is *unitas decima*. The difference is, that the word *sum* never had any other sense in English: while in Greek it never lost its first meaning, that of the item of enumeration. Thus *οἱ ἀριθμοὶ τοῦ σώματος* meant the limits of the body: Herodotus cannot tell what multitude (*πλῆθος*) each nation furnished to the enumeration (*ἐς ἀριθμόν*). And Aristotle distinctly lays it down that *μονάς* and *ἀριθμός* differ neither in *quantity* nor in quality: meaning that the thing which is *μονάς* when it stands alone becomes *ἀριθμός* when it stands in an enumeration as one of the items. Hence the Greek logicians could properly say that though a horse and a sheep differ *εἴδει* (in species), one horse and another only differ *ἀριθμῷ* (as different items of one species). The word *monadic* would be better than *numerical*, for logical use. See more details in the 'Transactions of the Philological Society.'

NUMISMATICS. The term numismatic, derived from the Greek *νομισμα*, is applied to the study of ancient and modern coins. By the writers of the 15th and 16th centuries it was called the science of medals. It divides itself into the following principal branches:—The study of coins considered in reference to the monetary systems to which they belong, or the study of the historical, mythological, and geographical allusions of inscriptions and types, and the discrimination of true ancient coins from modern imitations or forgeries. So vast is the extent of the subject that a perfect knowledge of all branches has never been attained by one individual. The value of ancient coins to the study of geography, history, and philology is considerable, for as they are monuments issued by public authority it must be assumed that the information they convey is correct; and they consequently offer many corrections to the orthography, in some instances they rectify the chronology, and even add to history and geography names which have disappeared from literature. Considered in reference to the arts they are valuable as showing their state at different fixed periods, while they present invaluable portraits of princes and illustrious personages, valuable representations of temples, statues, and localities, and important hints as to mythology and historical events. The study of them is however generally subjective, and they require elucidation from rather than give it to literature. In some instances indeed they hand down the knowledge of obscure sites, or give a clue to the history of dynasties which have not been recorded on the pages of the historian. As religious monuments they transmit a history of the local deities, and representations of their shrines and statues and the religious ideas of the age in which they were struck, and they afford considerable insight into the autonomous or free, and imperial administrations of states and cities, and their political changes, monetary systems, and dialects. But their great charm is their being monuments of ages long past, ancient pictorial illustrations of classical authors, undeniable evidences of a past state, and links which connect the familiar coins of the day with the first struggles of invention and the development of monetary systems. At the same time they are a most microscopical branch of archæology.

There can be little doubt that the Romans made collections of ancient coins, from the price paid for remarkable forgeries and the fact of their being inlaid and valued during the lower empire as gems by the laws. Petrarch, in 1374, was the first in the middle ages to collect them, Alphonso, king of Arragon, and Cosmo di Medici continued in the next century to do the same, and in the 16th century the study had so progressed that 200 cabinets were known in Holland alone. In the 15th century they were first introduced into literature by Angelo Poliziano, in 1490; and a series of writers the chief of whom were Fulvius, A.D. 1500; Mazochi, A.D. 1526; Veio, A.D. 1560; Golzius, A.D. 1526-83; Agostino, A.D. 1586; Ursinus, A.D. 1600; and Patin, A.D. 1633; wrote chiefly upon and illustrated the imperial Roman series. In England the study commenced with Speed, A.D. 1522, and Camden, in 1586. The works of this century are not remarkable for their accuracy, and it is not till the following that the study of numismatics began to acquire the rank of a science. Frölich, Corsini, and Cary availed themselves of medals to write history of the Bactrian, Armenian, and Bosphoran princes; but the most remarkable writers of the 17th and 18th centuries were Morell, A.D. 1703; Vaillant, A.D. 1706; Spanheim, A.D. 1664; Pellerin, A.D. 1782; Hardouin, in 1729; Patin, in 1695. In the 18th century the critical Eckhel completely reformed the study of numismatics, A.D. 1787-1808, while Mionnet, in 1770-1842, gave a complete list of Greek coins, and Rasche, a lexicon of important use for the study.

Important contributions to the study of Greek numismatics have been added by Millingen in 1831, 1837, 1841; by Barthelemy, in 1821; Böckh, in 1821; and others. The study is still kept up by four numismatic journals. The Numismatic Chronicle in England, commenced in 1836, the 'Revue Numismatique' of France commenced at the same period, that of Belgium started in 1843, and the 'Numismatische Zeitung' of Weissensee in 1834.

The origin of the currency is traceable to the Greeks alone; the Egyptians used rings of metal, and perhaps scarabæi; the Assyrians had no coins; and the Jews and Phœnicians at an early period were equally destitute of stamped money. The honour of this invention was disputed by the Greeks themselves. The Lydians, Hermodice the wife of Midas, Aryandes, Theseus, Itonus of Thessaly, the Naxians, and Pheidon of Argos, B.C. 895 or 772, were said to have invented the art. Opinions generally incline to Pheidon, from the rude antiquity of the Æginetan coins; but the dispute refers to the metals. At Athens and in Greece Proper gold was not struck till B.C. 440, the gold coins in circulation being darics, Cyzicene staters, and ingots. While, however, the oldest examples of the gold currency are Asiatic, the earliest silver was undoubtedly struck in the Isles and the Peloponnese, as is shown by the archaic coins of Ægina, Rhodes, Thasos, Thebes, and other cities of Greece. The earliest coins were chiefly didrachms, tetradrachms, and drachms, few pieces of smaller denomination having been struck.

Little or nothing is known about the Greek mint: that at Athens was called the *Argyrokopeion*; dies were called *kommata*. The coins were always struck, never cast, under the authority of eponymi. The names of engravers occur on coins during the most flourishing period of the art; after the time of Alexander, in some rare instances, with the form ΕΠΟΙΕΙ assumed by artists of the later schools, as ΝΕΥΑΝΘΟΣ ΕΠΟΕΙ. 'Neuanthos was making it' on a coin of Aptera, and Theodotos on a coin of Clazomenæ. This form is however often omitted, and the name of the artist put by itself, generally in the nominative. They are distinguished from those of magistrates by being in smaller letters, and occupying less prominent positions, being often placed in obscure places, as on the attire, on the adjuncts, amidst the type, so as not to intrude too prominently on the eye. The name of Aristobulus is placed on a gold coin of Lysimachus; that of Zoilos on a coin of Perseus. The dekadrachms and later coins of Syracuse have many artists' names, as Eumenes, Eucleides, and Cimon, and others; and in Magna Græcia are those of Augeas, Philistus, and others. Some worked for more states than one, as Parmenides, who engraved coins of Syracuse and Neapolis; Aristippus, who did so for Heracleia, Metapontum, and Tarentum; and this branch of the art was pursued by gem-engravers, the name of Phrygillus, known from a cameo, also appearing on the coins of Syracuse.[*]

The use of gold coins in Asia Minor is as old as that of silver in Greece Proper, and coins have been found which can be attributed to the age of Crœsus or Alyattes. Gyges, indeed, is stated to have used *oboloi* or spikes of this metal in the place of coins; and Crœsus himself presented plinthoi or ingots of gold to the shrine at Delphi. Talents of gold are mentioned by Homer. In Greece Proper the issue of gold is of later date, probably not older than that of Philip II. of Macedon. At the time of Herodotus its value to silver was as 1 to 13; but in the days of Plato and Alexander it had sunk as 1 to 12; but the gold of the Darics, on account of its extreme purity, was as 1 to 15; while that of Cyzicus, owing to alloy with silver, was only as 1 to 14. The gold unit was the stater, or sovereign, equal in weight to two Attic drachms, or 132·6 grains, called also the *chrysinos*, gold piece, or the Philippos, Philip. At Athens itself gold was not struck till the archonship of Antigenes, B.C. 407 (Ol. xciii. 2), when the golden Victories were melted down for the purpose; and prior to that period Phocæan or Cyzicene staters were current in the city. ('Böckh in Cavedoni;' 'Ant. monet. d'Atene,' 8vo, Mod., 1836.) The Attic staters have the head of Athene and the owl, besides which there is an archaic *hekte* of 21·6 grains, having an owl and incuse square. It has been attributed to the city, but it was probably struck in Asia Minor.

In the French collection, however, there is a complete sequence of Attic gold coins, consisting of a stater, drachm or hemistater, triobolon, diobolon, obolos, and hemiobolon, supposed to have been issued about the time of Pericles; gold obols of Argos, of 16·5 grs.; triobolon of Carystus, with head of Hercules and a bull, of 49·3 grs.; others of Aetolia, on the Attic standards, a triobolon of Bœotia, of 59·75 grs., and a drachm of Acarnania, are known. But the principal ancient gold coins are, the Daric, of 129 grs., with an archer and incuse square, worth 15–20 Attic drachms—the coins with which the Persians bribed the orators of Athens and Bœotia; the stater of Cyzicus, worth (B.C. 355) 28 Attic drachms, and mentioned as the monthly pay of a soldier by Xenophon, with the adjunct of a fish as its normal type; the stater of Phocæa, of 138 grs., and distater of 276 grs., and submultiples, tetarte 4th, hekte $\frac{1}{6}$, and hemihekta $\frac{1}{12}$, worth 8 obols; staters of Lampsacus, with the head of Poseidon or Priapus, and the winged sea-horse, of 129 grs.; and at Cyrene, gold octodrachms or tetrastaters, and the large issues of staters and its multiples by Philip II. and his successors, on a standard of 133 grs.; and the large gold dekadrachms, tetradrachms, pentadrachms, and other pieces of the Ptolemies. Many of these later pieces of Ionia, in the finest style of the art, are of electrum, and were issued as submultiples of an electrum stater. The largest piece was the 16-staters of Lysimachus.

The Greek autonomous silver coins have been divided into three periods, the first from B.C. 895 to 471, from Pheidon of Argos, or the Lydians, to Alexander I., of Macedon, the type simple and monstrous, often only animals, inscriptions short and monosyllabic, pieces thick and globular, engrailed rings like borders of Etruscan scarabæi, the reverses with hollow squares made by striking on a jagged die. 2. From Alexander I., B.C. 478, to Philip II. the art is much improved, the shape flatter and thinner, the inscriptions more complete, types are introduced on the reverse in the hollow square, which disappears under Amyntas III., B.C. 371; the types are surrounded by an engrailed ring. 3. From Amyntas III., to B.C. 100, about 300 years, the finest period of the arts, types on obverse and reverse complete, the age of Phidias, Zeuxis, Polygnotus, and Praxiteles, names of magistrates and engravers appear; portraits are introduced by the successors of Alexander the Great. This is also a great epoch for gem engraving. Greek gold and copper coins fall into this period. 4. With the rise of the Roman power the gold and silver disappear, a few imperial mints, such as Cæsarea in Cappadocia, Antioch, Amisus, and Tarsus alone continuing to have the privilege of striking either Roman denarii or larger pieces till the time of Hadrian. The mint of Alexandria struck silver or potin, till the time of Gallienus. The letters follow the rule of inscriptions, the titles are pompous. In this last period only copper was coined with the name of the cities.

The principal coins which have been found are, the dekadrachms, or large silver coins of Athens; the dekadrachms, or Syracusan medallions; octodrachms of Macedonia, the Athenian tetradrachms, called the stater or Atticus—a long series extensively imitated by other cities and by princes; the didrachms of Ægina and Corinth; the drachms used all over Greece and Asia Minor; the tetrobolon or $\frac{2}{3}$ drachm; the triobolon, or hemidrachm; the diobolon, or $\frac{1}{3}$ drachm; the trihemiobolon $\frac{1}{4}$ drachm; the obolos, or $\frac{1}{6}$ drachm, struck by cities prior to the introduction of copper; the hemiobolon, or $\frac{1}{12}$ drachm; and the $\frac{1}{4}$ obolos, or $\frac{1}{24}$ drachm; and $\frac{1}{8}$ obolos, or $\frac{1}{48}$ drachm, the smallest of all silver coins struck at Athens. In the Attic standard, the drachm weighed 67·377 grs., and the tetradrachm 269·508, and of this coin, the dollar of antiquity, called the γλαὺξ λαυριωτική, or 'Laurian owl,' from the mines of silver, and the type, 4 went to the gold stater, or chrysos; 25 to the mna, and 150 to the talent. Of these tetradrachms, which are the monetary standard of measure of antiquity, there are two types, the archaic coin, with the head of the archaic Athene, and the reverse an owl and olive-branch, which continued till almost the age of Alexander; and those of later than his reign with the helmed head of Athene of Pheidias, and the owl on an amphora, with the names of the three magistrates. These continued till the age of Mithridates, and even of the Romans.

In all the transactions of commerce, the drachm was the unit of value; the Attic standard was used at Corinth, Acarnania, Amphilochia, Leucadia, Epirus, Acanthus, Sicily and Cyrene; but under different forms, the Athenian coin was the tetradrachm, the Corinthian the didrachm—higher values are abnormal exceptions. The other standards were the Æginetan, consisting of 96 grs., introduced by Pheidon, from some Phœnician source, and the didrachms stamped with a tortoise which were called *chelonai*, tortoises, or *pacheiai*, thick, by the Athenians; they prevailed in Bœotia, Arcadia, Elis, Sicyon, Argos, Eubœa, Locris, and some of the isles. The other principal drachm was the Macedonian of 58 grs., which was used till the time of Alexander the Great, who substituted the Attic standard. Of Chios, there were pentadrachms, of 236 grs., supposing the drachm to have been about 47 grs. But the fact is, that it is still requisite to study the monetary history of each Greek state *per se*, as the currency was always slightly changing according to political circumstances and the rate of value, and the ancients had not probably the trial per pyx, or even a very accurate manner of determining the weight of their pieces, the irregular shapes of which offered tempting facilities for filing or paring.

The copper currency was the last introduced into Greece, and its appearance was not well received, it was first issued at Athens in the archonship of Callias, B.C. 406, and the orator who recommended it went by the nickname of the Coppersmith. The oldest dated copper coins are those of Æropus II., king of Macedon, B.C. 399; and the necessity of change diffused its use, and it ultimately superseded, or was current with all denominations as high as the obolos. The principal bronze coins are the obolos, worth 1⅓d. ·5, the *chalkous*, or ⅛ of an obolos, and the lepton, ⅐ of a chalchous: there were subdivisions of the ½, ¼ of an obolos, and pieces of 2 oboli, worth 3½d. Besides the oboli, there was an assarion worth $\frac{1}{16}$ of a denarius, and two other copper coins called the symbolon and kollybos, the value of which is unknown. Some of the monetary systems named the copper currency after the silver, and struck drachms, and didrachms and tetradrachms in this metal. Under the Roman empire, the copper currency was left to the care of the Greek municipalities, but after the national bankruptcy this was suppressed, and the copper issued only by the imperial mints. In the days of the republic, some of the states of Magna Græcia and Sicily used the Roman standard of the *as* and its subdivisions.

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[*] Brunn, Geschichte der Griecheschen Kunstler, 8vo, Braunsch., 1856, II. p. 414.

The types of the Greek coins had a religious aim, and either alluded to the eponymous deity, or some local tradition: their meaning was strictly religious. On the earliest coins the types consist of a single emblem, generally an animal or vegetable placed upon one side only: as the tortoise on the coins of Ægina, the dolphin on those of Thasus, the vine-leaf on Camirus. Some pieces were familiarly known by the names of their types; thus the drachms of Delos were called *boes* (cattle); the tetradrachms of Athens, *korai* (virgins), alluding to Athene, or *glaukes* (owls); the didrachms of Corinth, *poloi* (colts), from the Pegasus; those of Ægina, *chelonai* (tortoises); the staters of Macedon, *hippotai* (cavaliers); and the darics, *toxeutae* (archers). Other pieces were named after the princes who issued them, as, Crœsi, Alexandri, Philippi, Demerateioi, Ptolemaioi, and Berenicai. The types of the two sides often have a connection with one another, as the head of Apollo with the reverse of a lyre, that of Neptune with a trident, or the head of Hercules with his bow and quiver on the reverse. In many cases, however, no connection can be traced, as on the coins of Tarentum, and the artist selected his subjects from different statues or monuments.

Besides the principal types, various smaller representations, called adjuncts, are introduced upon the field on coins of the third epoch, especially on those of such states as struck a long series. On the coins of Alexander the Great and his successors, these *adjuncts* or mint-marks refer to the cities at which the pieces were struck, as a bee on those of the mint of Ephesus or Aradus, the club of Hercules for Tyre, an anchor for Abydos, a trident for Byzantium. On the contemporaneous coins of cities these episema have relation to the eponymous magistrates by whom the coins were issued; and a remarkable instance is the stag on a coin of Athens, the emblem of the great Mithridates with his name, and the elephant of Pyrrhus on coins of Tarentum. Such marks will be found on the currency of Athens, Corinth, the Achæan and Lycian leagues, and on the consular denarii; but they disappear at the time of the Roman empire.

The coins of the earliest period have no inscriptions, the type showing the state from which the coins issued; at first a single letter was introduced, the initial of the name of the city, as A for Argos, Θ for Thebes, ϙ for Corinth. By degrees these letters became monosyllabic abbreviations of the names of the cities, as ϙPO for Croton, ΠOM for Poseidonia, FA for Elis; dissyllables then appear, as AΘE for Athens, AIΓI for Ægina, PEC I for Rhegium, and these continued to the latest times. But as the arts developed, the inscriptions become more complete, as HIMEPA (Himera), MEΣΣANION (of the Messenians). These inscriptions generally give the name of the city in the genitive, as ΘAΣIΩN (of the Thasians); but the nominative sometimes replaces it, as MEΣΣANIOΣ (Messenian), ΣΥPAKOΣIOI (Syracusans); and unusual forms are found, as ΣEΓEΣTAZIBEMI (I am from Segesta), EPΥΘEMIΣH (I am the stamp of Erythræ), ΣEΥΘA KOMMA (the type of Seuthes). The neuter form is also found, as APKAΔIKON (Arcadian money). These inscriptions follow the style of the epoch, and are written from right to left, or *vice versâ*, and boustrophedon. Generally the name or initial of the city is on one side of the coin, occasionally it is repeated on the other; it is inserted to suit the type, at one side, across the area, or all round the hollow square: in some instances it is divided, the first half, as ABA, on one side, and KAINON (Abacænum) on the reverse. In some rare cases it is placed on the type, as AINI (Aenos) on the petasus of Hermes; APΓEI (Argos) and FAΛEIΩN (Elis) on the diadem of Hera. Till the fall of Greece into the power of Alexander, the civic legends generally continue very simple; but after that period epithets are used, as TΥP (*ου*) IE (*ρας*) AΣΥ (*λου*) (Tyre a sacred Asylum); and under the Romans the states are called by their epithets, as AΥTONOMOΣ (self-governed), ATEΛEIA (untaxed), EΛEΥΘEPA (free), MHTPOΠOΛIΣ (metropolitan), NAΥAPXIΣ (a port), AΣΥΛOΣ (an asylum), ΠPΩTH (first). Explanations are rarely given, as ΛAPIΣΣA ΘEΣΣAΛΩN (Thessalian Larissa), NIKAIEΩN TΩN KAI ΣKΥΘOΠOΛIΤΩN (of the Nicæans, alias Scythopolites in Samaria). The municipalities out of flattery often adopted Imperial epithets as KΛAΥΔIO-ΣEΛEΥKEΩN (of the Claudian Seleucians), TAPΣOΥ ΣEΥHPIANHΣ (of the Severian Tarsus), after Claudius I. and Severus. Occasionally the names of rivers are recorded, as HΥΨAΣ (the Hypsas) on coins of Selinus, APEΘOΣA (the Arethusa) on those of Syracuse; and the names of local deities often accompany the types.

The Demos (or people), Syncletus (or senate), and Boule (or council), appear on late coins. Alliances between the cities are indicated at an early period by the initials of two cities, at a later age by the word OMONOIA. The participation in games is shown by KOINON (community).

The names of persons appear first on the archaic coins of the second period, and generally in the genitive, indicating the eponymous magistrates. The earliest names are those of the kings of Macedon, the archons of Abdera, as AΛEΞANΔPOΥ, Alexander of Macedon, B.C. 474, and others. The title of king indeed appears with Getas, King of Hedonis, about 474 B.C., but it forms an exception to the rule, the title of king being first assumed by Alexander the Great. His successors adopted titles in addition to their names, and Antiochus XII. is called the King Antiochus, Dionysos, illustrious, father loving, Victorious. Besides the title of king, others appear, as the Ethnarch applied to Herod, and dynastes to Polemo of Olba. A rarer address is that of EΠI, "under," prefixed to the name of the magistrate, which occurs on the coins of Hicetas of Syracuse, but is commonly used on the imperial Greek coins. The inscriptions of these coins have prefixed to the names of the magistrates the offices which they held in the different cities, as the scribe (*γραμματευς*), archon (*αρχων*), mayor (*εφορος*), prætor (*στρατηγος*), propraætor (*αντιστρατηγος*), magistrate (*πρυτανευς*), treasurer (*ταμιας*), high priest (*αρχιερευς*), priest (*ιερευς*), or priestess (*ιερεια*), president of the games in Asia (*Ασιαρχος*), director of the gymnasium (*γυμνασιαρχης*), of the festivals (*π-νηγυριαρχης*), master of the games (*αγωνοθετης*), theologian (*θεολογος*). Some coins from the imperial times have inscriptions recording their dedication by individuals or magistrates to a district or city, as Hostilius Marcellus, priest of Antinous, has dedicated it to the Achæans. On the coins of Macedon, after its subjection to Rome, the name of the people is in Greek, MAKEΔONΩN, that of the magistrates, AESILLAS, in Latin.

Subordinate to the names of princes and magistrates are dates first introduced by the successors of Alexander. The Egyptian coins are dated in the Egyptian regnal year till the time of Di cletian and are preceded by ∠ (*λυκαβος*), or year; the imperial coins often have dates preceded by ET or ETOΥΣ, "year"—especially those of the east—the chief æras found are the Seleucian commencing B.C. 312, in Syria, Phœnicia, and Judæa; the Pompeian, B.C. 63, in Syria and Phœnicia; the Cæsarian, B.C. 47 or 48, in Syria; the Actian, B.C. 31, in Syria; the Egyptian, B.C. 300, commencing with Ptolemy I.; and that of Pontus, B.C. 296.

The names of games, as KAICAPEIA, the Cæsarian, ATTAΛEIA, the Attalian; and many others are inscribed on imperial coins.

Inscriptions recording the value are seen on a few rare imperial coins, as ΔIΔPAXMON, a didrachm, on a silver coin of Nero, struck at Cæsarea, in Cappadocia; and on a copper coin of Rhodes, ΔPAXMH, or ΔPAΓMH on those of Ephesus; and ΔPAXMA on a bronze coin; AΣΣAPION, ΔVO, TPIA, HMIΣV on the copper of Chios; TPIOBOΛO[N] on those of Samothracia; HMIOBEΛIN on those of Ægium; XAΛXOΥΣ on coins of Antioch; ΔIXAΛKON on those of Chios.

Single letters besides the names of magistrates and cities, and ligatures of letters called monograms, are of frequent occurrence on the coins. Sometimes the names of cities are thus compressed, as $\genfrac{}{}{0pt}{}{\sqcap}{\mathrm{A}}$, Parium; $\genfrac{}{}{0pt}{}{\mathrm{X}}{\mathrm{A}}$, Achæa; $\genfrac{}{}{0pt}{}{\mathrm{Y}}{\mathrm{T}}$, Tyre; or the name of the eponymous magistrates; dates are rarely thus expressed. On the coins of some cities and princes, solitary letters are used to indicate the order of the issue of the coins from the mint, the letters being used in alphabetical order, and when the series was exhausted the letters were doubled for a new series. The silver coins of Arsinöe have single, and the gold double letters to mark the order of issue.

It has been usual to consider the currency according to the system of Eckhel, or a geographical order from west to east, while the actual chronological sequence is from east to west, the earliest coins being of Asia Minor and the Isles of the Ægean. A still more philosophical arrangement would be that of the coins of each stage of the currency. The coins of Britain and Spain are imitated or derived from the coins of Philip II. of Macedon, or Hiero II. of Sicily; the types of the copper are rude portraits of Greek gods, and symbols, as grapes on the coins of Acinippo, alluding to the name of the cities. The gold and silver are copied from the Roman aurei and denarii of the Consular period, and of a similar standard and type as the Dioscuri; even the copper have the uncial globules which mark the subdivision of the *as*. Their legends are in the Celtiberian characters, derived from the Greek and Phœnician, and they are supposed by some to have been issued as early as B.C. 200, by others as late as B.C. 84–74, the date of the insurrection of Sertorius, and named the Oscense argentum, from Osca, his capital. (Livy, xxxiv. 10, 41, xli. 43. De Saulcy, 'Monnaies Autonomes de l'Espagne,' 8vo, Metz, 1840; Gailliard, 'Description des Monnaies Espagnols,' 4to, Madr., 1852.)

The coins of Gaul are divisible into three periods. 1. Earliest imitating the staters of Philip II. & III. after the conquest of Macedon, B.C. 278. 2. Those with Latin legends apparently from B.C 100-21. 3. Those with the names of cities and chiefs on each side, the inscriptions either in Greek or Latin, or both mixed. These last two classes imitate the Consular silver, but with great provincial variety. Besides the Celtic coins are the earlier coins of Massilia or Marseilles, Glanum, with the type of a female head and lion of elegant workmanship, and belonging to the Greek series, consisting of the drachm and its subdivisions. The Gaulish series contains staters, of drachms of silver, and potin of 6 copper, 2 lead, 1 tin, or copper of small size to imitate *lepta*, and the first are cast. Besides these are bronze coins of two colonies, Nemausus or Nîmes, founded with veterans from the Egyptian campaigns, and having on the obverse the heads of Agrippa and Augustus, and on the reverse a crocodile bound to a palm tree, and Lugdunum or Lyons, with the head of victory and a lion. The earliest British coins, like those of the Gauls, are imitations of Philippi, and are followed by those of chiefs and kings of A.D. 100, the most remarkable of whom are Cynobelin, Tasciovanus, Dubnovellaunus. They are in all metals, of small size, on the Greek standard, and exhibit great local differences: two cities are named on these coins, Verulamium and Camalodunum.

Following the western arrangement, the next coins are those of Italy and Sicily. I. The Greek series is remarkable for its number, the beauty of its art, and the interest of its types. The art is of a softer and more florid character than that of Greece Proper, and there are no coins so old as those with incuse squares of the older Greek style, but instead a remarkable kind having the type in relief on one side, and incuse on the other, like bracteats or embossings on paper. All these Greek coins are struck in Southern Italy or Magna Græcia. The oldest coins are of Sybaris, destroyed B.C. 510; drachms and demidrachms with a bull; of Poseidonia, subsequently Pæstum, B.C. 453-448 with Poseidon; Croton, founded by Achæans, B.C. 710, with the tripod of Apollo taken by Hercules from Delphi, Hercules and Apollo destroying Python; of Metapontum, B.C. 700, with the golden summer or ear of corn surmounted by a grasshopper, Apollo and Artemis; and of Caulonia with Apollo; of Laos, with an ox; and of Termesa with armour. Of the best period of art are the beautiful coins of Thurium, with the helmeted head of Athene, with Scylla and the butting bull, those of Locri with the shade Ajax Oileus, Rome and Faith; of Rhegium with the horse and mules of Anaxilaus, of Velia with the helmed head of Athene, and a lion; of the Brettii, with Neptune and Venus of fine art. Still more remarkable are those of Tarentum, with Taras and Phalanthus, and the young Taras running to his father Neptune; Heraclea its colony, B.C. 443, has the head of the Lacinian Juno and Hercules, Cumæ, Glaucus, Scylla, Cerberus alluding to the Sibyl, and crabs; Neapolis and Nola, the head of Parthenope and Dionysus Hebon; Hyria has Minerva and Juno; Terina the goddess Pandeina or Iris drawing the water of the Styx; Arpi, Ceres and a horse. Many of the coins show the state of political events, elephants indicating Pyrrhus and Hannibal at Tarentum and Cumæ, and the head of Janus, the progress of the Roman power.

II. Coins inscribed in the languages of the people of Italy. The principal of these are the Oscan coins of Capua, Atella, Teate, and those issued by the confederated chiefs in the time of the Social and Marsic wars, imitating the Roman denarii in weight and type, but of much ruder character and workmanship; one of these has the word *Safinim* or Sabinorum in the Oscan dialect.

III. Coins with Etruscan inscriptions consisting of one or two gold of uncertain authenticity, a few silver, and a large series of the As Grave and its divisions issued by Cortona, Volaterra, Tuder, Iguvium Vestini, Hadria, Firmum and Ariminum, the last with the head of the victorious Gauls.

The other ases have various types for each state and series, but the wheel is a normal type, besides which are other unascertained series of Etruscan states.

The coins of Sicily are as fine as those of the Peninsula, but none belong to the first period of art with hollow square. The island is remarkably rich in silver coins. The tetradrachms of Agrigentum have the river, the sea eagle, and the crab; the tetradrachms and didrachms of Camarina, Hercules, Athene, and the Hipparis; the tetradrachms of Catana have chariots; those of Gelas the river as a human-headed bull, or as a horned youth; the didrachms of Himera, the cock sacred to Æsculapius, and the river. The tetradrachms of Leontini have the lion's head, the celebrated corn of its plains and chariots; the drachms of Messana, the curved port, and the types of its Samian colonists, a lion and bull, the horses, mules, and chariots of Anaxilaus, as the Mamertini Mars; Naxos has beautiful tetradrachms with a couchant Satyr; the tetradrachms of Segesta the Crimisus, and the nymph Segesta; the tetradrachms of Selinus, Apollo and Artemis Epicurioi and the Hypsas sacrificing. Syracuse has many types, but they principally are chariots, referring to the reputation of Sicilian horses, to obtain which Alcibiades is said to have projected the unfortunate expedition of the Athenians. The earliest dated coin, the dekadrachm or Demarateion, B.C. 479, has the head of the Arethusa surrounded by dolphins, a biga and the lion of Gelo I.; the later tetradrachms supposed to be struck under Dionysius I., B.C. 368, have the same head in a less archaic style, a quadriga with a panoply of armour, and the word *athla* prizes. The gold pieces are also fine, and the currency of the princes commencing with Agathocles, and ending with Gelo II., and comprising the queen Philistis, only known from her name on the seats of the theatre, is remarkable for the beauty of work and art embellishing their portraits. Besides the Greek coins there are tetradrachms with Carthaginian legends struck in Sicily, and others of finer work attributed to the second Dionysius.

The islands near Sicily have Phœnician deities and legends, and principally copper coins. In the Crimea or Tauric Chersonesus, the normal type is the head of Panticapæum. Istrus, the Medusa's head reflected. In Thrace the didrachms of Abdera have the gryphon; those of Aenos of remarkable beauty, the head of Hermes and the wine-press. Byzantium, which is said to have issued iron money, has the bull, and the head of its founder, Byzas. Maronea, has a series of fine tetradrachms with the horse of Poseidon and the vine of Dionysos, alluding to its wines. Thasos has triobols with the head of Dionysos, and an amphora. The regal series is rich in didrachms of Seuthes I., with a horseman and remarkable inscriptions, and with the copper of Seuthes III. A beautiful suite of coins is those of Lysimachus, whose staters imitate Alexanders, and whose tetradrachms struck all in Asia and Europe, like the series of Alexander, as at Ephesus, Methymna, Tomi, and Byzantium, have on one side the head of Alexander with the ram's horn, as son of Ammon, and on the other Pallas Athene Nicephoros seated. At Chalcedon, in Bithynia, the tetradrachms give the veiled head of his consort Arsinöe. There is also a remarkable tetradrachm of Mostis struck by Sadalus in the 47th year of his reign, with a portrait.

In the neighbouring state of Macedonia, the tetradrachms of the province struck in the first division, at Thessalonica, have the head of Alexander, the club of Hercules, and the name of the questor Æsillas; the second and fourth divisions are found, but not the third; the didrachms of Acanthus have a lion devouring a bull, and are of the second period. Aeneia has the head of Æneas; the beautiful tetradrachms of Amphipolis, the laureat head of Apollo, and the torch of the lampadophoria; those of Chalcidice, the head of Apollo and his lyre; the archaic ones of Lete, a satyr and nymph; Neapolis, a Gorgoneion; of Philippi the ancient Cranides, there are staters with the head of Hercules, and the Delphic tripod.

Of the princes of Pæonia, commencing with Audoleon, B.C. 340-330, there are fine didrachms with a helmed head and horse; those of Eupolemos, Lycceius, and Patraus, have a horseman overthrowing an enemy. The regal series of Macedon are remarkable for the light they throw on the history of the coinage. The coins of Getas, king of the Hedones, represent a man and two oxen; those of his contemporary, Alexander I., a man and horse; a very archaic dekadrachm has a man in a car drawn by a bull; and in the area the helmet of Caranus. There are drachms, didrachms, and obols of Archelaus, bronze coins of Æropus, didrachms of Pausanias and Amyntas II.; drachms and brass coins of Perdiccas III.; the goat refers to those which accompanied Caranus to Ægæ. The staters of Philip II., coined from the gold of Mount Pangæum, have the head of Apollo alluding to Philip's protection of Delphi, and a two-horse chariot, alluding to his victories in the Olympian games; the silver currency, principally didrachms, have the head of Zeus and a rider. Of Alexander the Great there is a great series of two or three issues; this monarch recoined the whole currency of his empire, and struck numerous double staters with the head of Pallas and Victory, and tetradrachms with the head of Hercules and Zeus Olympius, in copper in the principal cities, suppressing the local mints; the places of mintage are distinguished by the symbols of the coins of the cities where minted, placed in the area with the initials or monogram of the name of the city, as the Rose for Rhodes, the head of Chnephis for Alexandria, the bee for Ephesus, the lion and bull for Miletus. The names are given in contraction or by monograms as **MYPI** Myrina, **ΚΟΛΟ** for Colophon.

Philip III., has staters and its subdivisions, tetradrachms on the type of Alexander the Great, and is distinguished from his predecessors by the assumption of the title of King. Cassander, struck only brass, with the head of Hercules and a lion. Philip IV. and Alexander IV. only drachms and small coins; Antigonus, staters with the head of Pallas and a trident, fine tetradrachms with the head of Dionysos, and Apollo seated on a ship, referring to the victory of Cyprus, B.C. 306; Demetrius I., staters on the type of Alexander, tetradrachms with his portrait, and Poseidon; others with Poseidon Promachos, and Victory sounding a trumpet on a galley, for the victory at Cyprus. Antigonus Gonatas, has tetradrachms, convex, like the silver shields of the Argyraspides with the head of Pan, and Pallas hurling thunder, on his copper Pan erects a trophy. Passing to Philip V., there are fine tetradrachms on the type of Antigonus, with the head of Perseus and the club, or his portrait, and Pallas hurling thunder, besides didrachms, drachms, and copper. Of the unhappy Perseus, B.C., 168, there are fine tetradrachms with his head, and the eagle and thunderbolt by the artist Zoilus. Of Philip VI., there are only copper.

Thessaly abounds in silver coins, the principal type is the horse, the drachms have the head of Zeus crowned with oak, and the Pallas Itonia, the eight obol pieces of the Aenianes, the head of Pallas and the hero Phenicus slinging, the triobols of Lamia, the ivy crowned head of Dionysos, and a diota, or a tripod in a square, the drachmæ of Larissa have Jason and the bull of Colchis, the horse in a square, the sandal of Jason left at the Anapus, the head of the hero Aleuas and the eagle and thunderbolt; the didrachm, the head of Larissa or Coronis and a horse; those of the Octaei Hercules and a lion or spear; the drachmæ of Phalanna a youthful head and horse; those of Pheræ a female drawing water from a fountain; of this town are the tetradrachms of the tyrant Alexander, B.C. 363-359, with the head of Larissa or Coronis and a horseman. The early tetradrachms of the Oreskii have a horseman with horses and spears. The coins of Illyricum are not interesting; the drachms of Apollonia have dancing nymphs and a volcano. Of Epirus there are tetrobols with the heads of Zeus and Hera and a thunderbolt in an oak crown. The most important coins are those of the monarchy—of Neoptolemus and Alexander, B.C. 362-322, there are only brass; but of Alexander I., B.C. 342-332, there are staters of fine work with the head of Zeus and a horseman, and silver obols with Helios; those of Pyrrhus, B.C. 294-272, are of great beauty, and consist of hemistaters with the head of Artemis and Victory with a trophy and crown; staters with the head of Pallas-Athene and the same, and also drachms with the head of Proserpine and Athene-Promachos struck in Sicily; Dyrrhacium has early coins like Corcyra and drachms with the head of Dionysos and a Pegasus of Corinth; the didrachms of Anactorium have the head of Pallas and Pegasus; the didrachm of Leucas has Artemis Nauplia with a ship and hind; Thyreum, Achelous and Apollo; Aetolia the Achelous and Atalanta amidst shields, and triobols with the head of Atalanta and the boar of Calydon. The didrachms and hemidrachm of Locris offer the head of Persephone and Ajax Oileus, the old drachms and triobols of Phocis the bucranium suspended on the temple and the head of Apollo. The archaic didrachms of Thebes and Bœotia have the celebrated bucklers; the later didrachms the head of Dionysos, his golden amphora, and Poseidon, Hercules strangling the serpents, or shooting an arrow, a rare tetradrachm, the head of Zeus and Poseidon.

The coins of Athens have been already described; the lepta of Eleusis have Demeter in a biga of winged serpents and a sow; those of Megara, the head of Apollo and his lyre. Of Achæa there is a remarkable series of the league, with the head of Zeus and the monogram of Achæa and the initials of the towns; others have Zeus Nicephorus, and Demeter. The didrachms of Corinth have the ϙ for the initial of the name of the city, the head of Pallas Chalinitis in the Corinthian helmet, and Pegasus, or Bellerophon and the Chimera; on the imperial are Ino, Melicerte. The drachms of Patræ resemble those of the Achæan league; those of Phlius have a wheel. The archaic drachms of Sicyon have a flying dove, with ΣE, the archaic initial of the city, of great beauty; the later, a Chimæra, with the same bird, and are of great beauty. The archaic didrachms of Elis have an eagle with a serpent, emblem of Olympian Jove, and FA for Falis, the Æolic name of the city, with a thunderbolt; later coins, the eagles feeding off hares, and a winged Victory seated; and the last, a copy of the head of the celebrated Hera of Polycleitus, with her name Hera inscribed upon the kredemnon or attire. The drachms of the Cranii in Cephallenia have the ram of Helle; Zacynthus has the head and tripod of Apollo; Ithaca, Ulysses.

The Messenian didrachms have the head of Demeter or Persephone bound with ears of wheat, and on the reverse Zeus Ithomatas; the drachmæ of Laconia, the head of Hercules; and the tetradrachms of Cleomenes the portrait of this monarch and the armed Aphrodite, and on late copper Lycurgus himself. The drachms of Argos, a wolf; the smaller pieces the protome of a wolf, and on the reverse A in a square, the head of Hera, and Diomed; Trœzene has the trident of Neptune. Those of Arcadia have Zeus Lycæus with an eagle, and a female head in a square; the silver coins, the head of Pan; the hemidrachms of Heræa, the head of Hera; Mantinea, the bear and acorn; those of Megalopolis, the laurelled head of Zeus Lycæus, and Pan seated holding a pedum, and an eagle on Mount Lyceius; Pheneus, the heads of Proserpine and Meleager; Stymphalus, the head of Artemis, and Hercules and the Stymphalian birds. In Crete the art of the coins is peculiar, rather coarse, and the pieces are often large. The drachms of Aptera have the head of Zeus or Hera, and Hermes or Apollo and Apteras; those of Gnossus, the Minotaur holding in each hand a bull, and the labyrinth; the didrachms, the head of Minos, Hera or Ariadne; those of Cydonia, the ivy-crowned head of Dionysus, and Cydon with his hound, holding a bow; the tetradrachms, Artemis, with a hound and torch. The drachms of Elyrus have a bee of the celebrated hives which nourished the Cretan Zeus, and the celebrated goats which by eating the herb dictamos drew the iron from their wounds; the old didrachm of Gortyna, Europa seated in the tree, with Zeus as an eagle, and Zeus under the form of the bull; Hierapytna, a palm tree and eagle; the didrachms of Itanus, Tritons and two sea serpents; the very old drachms of Lyttus, a flying eagle and the forepart of a boar; the didrachms of Phæstus, Hercules killing the hydra, bulls and ear of corn, and an ox bound and feeding, or the winged Talos hurling stones at all who approached the island, and Zeus Gelchanos seated on a tree holding a cock. Polyrrhenium, Priansus, and Rhaucus have interesting coins. Eubœa has Aphrodite; the tetradrachms of Carystus, a cock, and a calf sucking a cow. The didrachms of Chalcis, Apollo and a lyre; the triobols of Histiea, the head of Hera, and the prow of a ship; the tetradrachms of Eretria, the head of Artemis Amarynthia, and a bull with a fillet on his horns. The old didrachms of Ceos, a bunch of grapes and incuse square; the didrachms of Melos, a pomegranate. Ceos has a pomegranate; Coresia a sepia, the copper of Julis, the head of Aristæus, and a bee; the didrachms of Paros, mentioned by Hesychius, have the head of Ariadne and a goat; Tenos has the head of Dionysus, with the ram's horn and grapes.

The Asiatic coins commence with the Cimmerian Bosphorus, which extend from B.C. 289 to A.D. 337. The first of them, those of Parisades, staters, resemble those of Lysimachus. The tetradrachms of Mithridates III., B.C. 297–266, are of fine although barbaric work, with a good portrait. Those of the great Mithridates IV., B.C. 123–62, both the staters and tetradrachms, give fine portraits of the king. Those of Pharnaces II., B.C. 62-47, are nearly as fine. The later kings, commencing with Asander, B.C. 46–13, struck a series of gold and electrum staters, didrachms of base alloy, and copper, with portraits of the Cæsar as their reverses and dates. Those of Pontus are not remarkable. Amastris has the head of Amastris the Amazon, its founder The tetrobols of Cromna have the heads of Zeus and Hera; the drachms of Sinope with Greek or Phœnician inscriptions, have the head of the local eponymous nymph and an eagle devouring a tunny. The brass obols, Perseus and the Ægis. In Bithynia, the old drachms of Chalcedon have a bull and incuse square; the drachms and trihemiobols of Heraclea, the heads of Hercules and Hera; the drachms of Cius, the head of Apollo and a ship; the didrachms of Heraclea, Heracles and the city, and didrachms of the tyrants Timotheus and Dionysius. There is a fine regal series of tetradrachms and copper of the kings of this state, with portraits, as Nicomedes I., B.C. 276-250, Prusias II., B.C. 149, with his head winged as Perseus and Jupiter, and of Nicomedes II. These coins are dated with the Bithynian æra.

In the neighbouring state of Mysia, the most remarkable autonomous coins are those of the celebrated electrum and gold stater system of Cyzicus, already mentioned, and tetradrachms with the head of Proserpine and a lion's head. Of Lampsacus, there are staters with the head of Poseidon, the bust of Demeter, and hippocampus; the didrachms have Hercules. Of Parium, there are staters with the head of Demeter, and drachms with a goat. The most remarkable of the coins of Pergamus are the cistophori, or tetradrachms, with a snake escaping from a basket, all in an ivy crown, or two snakes entwined round a bow. A fine series of tetradrachms of the kings of Pergamus commence with Philetærus, B.C. 288, Attalus I., B.C. 241-147, Eumenes II., B.C. 197-159, Aristonicus, with their portraits, and Pallas Athene. Of the Troas, the drachms have the Gorgonium, and an anchor or eagle, and Trojan myths.

The coins of Abydos have the head of Pallas, Artemis, and the Gorgonium, an anchor or eagle; of Alexandria Troas, the head of Apollo Smintheus, and a pasturing horse; the tetradrachms of Tenedos, described by Aristotle and Suidas, have a double head and the bipennis with which Tenes cut the fatal rope. The drachms of Aegæ in Aeolis present the head of Apollo and Zeus Aetophoros and a goat; the tetradrachms of Cyme the head of the eponymous Amazon, a horse, and jug; those of Myrrhina, the head of the Grynæan Apollo, a female offering, and a diota. The island of Lesbos struck for itself only bronze coins, but the drachms of Methymna have the head of Pallas and a bull, of fine work and old style; Mytilene the head of Apollo and a lyre; Clazomenae has beautiful staters with the head of Apollo and a winged boar, and didrachms with the same head and a swan; of Ephesus there are staters with the head of Artemis and the Ephesian Artemis; cistophori, tetradrachms with a bee, deer, and a palm-tree. Erythræ has a stater with a stag; the tetradrachms of Magnesia have the head of Artemis and Apollo on the Mæander, the didrachms, a rider and bull; one has the name of Themistocles, then its dynast. Miletus offers coins of the oldest style with the laurelled head of Apollo, a lion, and star; Phocaea has staters and silver coins with a seal; Smyrna, a double stater, with head of Cybele, and a female; bronze coins with Homer; and sesterces struck by the prætor Theudianos. Teos has silver didrachms with a gryphon, and brass coins with Anacreon. The type of Chios in gold and silver is a sphinx and diota. Samos has the head of a lion and forepart of a bull. Antiochia, of Caria, has the head of Apollo and a Pegasus. Of Cnidus there are coins of great antiquity, with the heads of Aphrodite and a lion; Myndus, Serapis and his head-dress; Nysa, the rape of Proserpine; Termeros has a trihemiobol of Tymnus its tyrant. Of the Carian princes, commencing with Hecatomnus, B.C. 381, and ending with Pixodarus, 336, there is a fine series of tetradrachms, didrachms, and drachms, the normal type of which is Zeus Labrandenos. The didrachms of Calymna have the head of Mars and a lyre. Of Cos, there are silver coins with Hercules and crabs, and tetradrachms with the dance of Apollo before the tripod, while the brass coins have Aesculapius. The gold and silver coins of Rhodes have the head of the Colossos and the rose.

The coins of Lycia consist of an early series of didrachms, drachms, and trihemiobols, of the earliest Attic standard, with incuse squares with symbols, the types of the oldest B.C. 600; the normal type is a ring with three or four hooks. These early coins have inscriptions in the Lycian characters, and the names of Tlos, the Troes, Pinara, and other cities, are found on them. A later series of didrachms, having on one side the head of Pallas armed, and on the other the head of a satrap, and inscribed Ddenenefele, Pttarasu, Feggsere, Arina, and Garue, probably record the names of satraps after the Persian conquest. (Sir C. Fellowes, 'Coins of Lycia,' 4to, London, 1855.) Of Lycia there are also a series of drachms struck by the Lycian league, with the head of Apollo and lyre, and the initial letters of the states.

In Pamphylia, and Aspendus, the didrachm has wrestlers, three legs, and a barbaric legend; Perga didrachms of the post-Alexandrine epoch, with Artemis Pergaia; Side, a series of fine tetradrachms, with the head of Athene, Victory, and the pomegranate, the name and emblem of the city. The states in Pisidia are numerous: the coins of Selge with slingers, and Andeda are the most interesting. The bronze coins of Iconium have the eikon or portrait of Perseus. In Cilicia, Celenderis has didrachms with a kneeling goat looking behind, and a horse; Nagidus, Dionysos; Mallus, an Asiatic deity, Hermes and Herse. Olba brass coins with the portraits of the priest, princes, Polemo, and Ajax. Soli didrachms with a head of Pallas, and bunch of grapes. Pompeiopolis, the heads of Pompey and Aratus. The didrachms and tetradrachms of Tarsus have Tyche, or Fortune, Zeus, a lion, a lion devouring a bull, and the kings Tarcondimotus, and Philopator I., in B.C. 100–1.

The most remarkable coins of Cyprus are the gold and silver with the heads of Zeus and Aphrodite commenced by Evagoras, B.C. 380, and continued by his successors. Those of Amathus with a ram, and Soli with Astarte. In Lydia, the principal coins are cistophori, of Sardis and Tralles, and numerous imperial coins. Phrygia is chiefly remarkable for the cistophori of Apamea, Laodicea, and a series of imperial coins. Of Galatia there are bronze coins of some towns of imperial times, and of the kings, Deijotarus, the friend of Cicero, and Amyntas, B.C. 36–25. Cappadocia is chiefly remarkable for the imperial mints at Cæsarea, which struck in all three metals, with the portraits of the emperors and the mountain Argæus; and the tetradrachms, didrachms, and drachms of the kings Ariarathes and Ariobarzanes, B.C. 220–17. The coins of a few kings and Tigranes are the only ones that can be referred to Armenia. Of the Syrian kings there is a long series in all metals, but chiefly tetradrachms, commencing with Seleucus I., B.C. 312, and terminating with Antiochus XIII., B.C. 60. These have generally on one side the head of the monarch bound with a diadem, and on the other Apollo on the cortina. The most remarkable are the tetradrachms of Seleucus I., representing him in a triumphal car drawn by elephants; the staters and tetradrachms of Tryphon having on the reverse a helmet with a horn; the unique coins of Cleopatra, mother of Antiochus VIII.; those of Antiochus VIII., with the reverse of the tomb of Sardanapalus at Tarsus. All these coins have indications of the cities where they were struck; they are of great beauty but difficult to assign to the proper princes. There is a coin of Iotape of Commagene with her head and scorpion, struck B.C. 70–40. Of "Antioch the Great" there are autonomous bronze coins, with Zeus, the tripod, and the Pompeian æra; then the imperial coins, with the celebrated statue of the city on the reverse, and autonomous coins with the Actian æra, with a lyre, ram, and sun and moon; finally, imperial tetradrachms with the Cæsarian and Actian æras, from Galba to Volusian, and copper of the Roman colony with S.C. on the reverse, from Antoninus Pius to Valerian. The coins of Apamea have an elephant, but of Laodicea there is a tetradrachm with the head of the eponymous Amazon, and Zeus Nicephoros. Of Damascus there are both autonomous and imperial coins; some of King Aretas, with the head of Cybele, or Dionysus, and a deer. Berytus has silver with the same head and a deer. Sidon has tetradrachms with the portraits of Antiochus IV., a ship and Astarte, and bilingual copper. Tyre has coins with the head of the Seleucidæ from Antiochus IV. to VIII., the eagle, or the Tyrian Hercules Aradus, tetradrachms, with the head of the city and a Victory.

The coins of Judæa do not date earlier than Simon Maccabæus, B.C. 144–135, who issued shekels of silver with the manna pot, and Aaron's rod, the beautiful gate of the temple, and inscribed in Samaritan characters, with 'Jerusalem the Holy,' and 'the shekel' or 'half-shekel of Israel,' and the year of his reign, or the 'liberation of Israel.' The subsequent monarchs, such as Herod Antipas, B.C. 4-39 A.D., and Herod the Great, and Agrippa II., issued copper lepta, the widow's mites, the Romans having taken away the right of coining silver. The coins of Arabia, Mesopotamia, and of the kings of Edessa have little interest. Those of Timarchus, king of Babylon, B.C. 164-62, are rare.

The series of Parthian coins consists of tetradrachms, drachms, oboli, and copper coins; the drachms commence with Arsaces II., B.C. 253, and terminate with Vologeses V., A.D. 227, their maximum weight is 54 grs. Their normal type, the head of the monarch in a tiara with the Scythian Apollo. The tetradrachms commence with Arsaces VI., or Phrahates I., B.C. 181, and continue in their series, their maximum weight is 222 grs., their types are rather more diversified, having the king seated, Victory, Hercules, Fortune. The brass coins commence with Arsaces III., or Artabanes, B.C. 216. Their types are still more varied. These coins have on them the date of the year, and the name of the month in which they were struck. In Persia, the early Achæmenidæ struck both the gold and darics. The later Sassanidæ struck a series of coin of flat character, having on one side their bust in oriental attire, and on the reverse a fire altar, at first accompanied with Greek, and afterwards with Pehlvi inscriptions, commencing with Artaxerxes I., A.D. 223, and ending with Chosroes I., A.D. 579. Bactria, the present Cabul, has coins of a dynasty of princes unknown to history, commencing with tetradrachms of Diodotus I., B.C. 250, and Euthydemus, B.C. 245, Eucratides, B.C. 180, and continuing till Mayes, B.C. 95. The coins of these princes are struck on the Greek standard and model, and have allegorical legends with Bactrian inscriptions. These coins are succeeded by those of Parthian princes, commencing with Azes and Mayes, of square shape, principally didrachms, and with Arian legends, and end with the Indo Scythic gold coins of Kadphises, B.C. 85, and Kanerki, A.D. 40, with a figure of the monarch, the god Mithras, and the bull Nandi. Of the characene there are only the coins of the monarch Monoeses.

A series of coins with Phœnician inscriptions, were struck by the Satraps of Persia in Syria, Phœnicia, and Asia Minor, Palestine, and Cyprus, besides which, the kings of Phœnicia and Gebal struck coins with Greek types and Phœnician inscriptions (De Luynes, 'Numismat. des Satrap,' 4to., Paris).

The coins of Egypt are a remarkable series, commencing with the Aryandics. The Lagidæ have a long series of fine didrachms, tetradrachms, drachms, and staters, and tetrastaters, and pentadrachms. The normal type is the head of the monarch on one side, and on the other, an eagle or cornucopia, with the name, sometimes titles of the monarch, adjuncts and monograms of the cities of Syria, Cyprus, and Egypt, in which they were struck. Great difficulty is however felt about the assignment of many of the coins. The most remarkable pieces are the gold of Soter, with Alexander's body transported in a quadriga of elephants, those with the heads of Soter and Berenice on one side, and Philadelphus and Arsinöe on the other, the large gold and silver series of Arsinöe. There are only copper and silver of Cleopatra and Antony. The brass currency, apparently adjusted to the brass talent, has remarkably large pieces, and submultiples of small size, generally with the head of Jupiter Ammon and one or more eagles. The coins of the Ptolemies are well executed, and of great beauty and interest.

The Romans adopted, on their conquest, the system of the Ptolemies, and the use of the Greek language, striking didrachms of a base silver, with the head of the emperor accompanied by his titles on one side, and on the other allegorical figures copied from the Roman coins, with the date of the year in which they were struck, offering an important series for the chronology of Rome. These didrachms commenced under Tiberius and Nero, and continued till the Antonines; more alloy was used under Marcus Aurelius and Commodus. From Septimius Severus to Gallienus mere potin was employed, and the didrachms give place to the last, and become rare after Gallienus. From Aurelius to Diocletian only copper of small size but thick were in use. After the revolt of Firmus, A.D. 272, the mint was left at Alexandria, and continued till the close of the Lower Empire, but Latin legends were introduced on the coins A.D. 296. The copper coins are the large brass, or tetradrachms, of about 290 grs., the second brass, or didrachm, of 136 grs., the drachm of about 63 grs., adopted on the standard of the Roman brass. The coins of the nomes commence the 12th year of Trajan, and end the 8th of Antoninus; they have the legends, deities and sacred animals of the nomes.

The other coins of Africa are those of the state of Cyrene, consisting of early of the time of the Battiadæ, of the republic, of the Lagidæ, and of the Pentapolis, B.C. 96. The gold tetrastaters, staters, and hemistaters have the head of Jupiter Ammon and the Silphium, or Assafœtida, sometimes with the gerboa on the stalk; the tetrobols with a rider and the Silphium are very fine; the silver currency with like types is also fine. Of the revolted Magas, B.C. 256, there are only bronze coins, with his portrait, and of Ptolemæus Apion, B.C. 96, silver and brass. The states of Leptis, Sabratha, Byzacene, and Zeugitana, offer little numismatic interest, and of Carthage itself there are no coins, although a fine series of Carthaginian coins was struck in Panormus. Hippo Libera and Utica have coins with the supposed heads of Libya and Julia Augusta. Certain coins with Punic legends have been assigned to Mauritanian princes, Masinissa, Micipsa, Jugurtha, and Hiempsal II., and of these are drachmæ with portraits and Latin legends of Juba I., II., Ptolemy, and Cleopatra.

The imperial series struck in the Greek cities under the Roman empire has considerable points of interest, showing the state of the arts, the nature of the magistracies, the titles assumed by the cities, occasionally as still enjoying their municipal freedom. They placed on their coins the heads of the personified *Demos*, or People; *Synkletos* or Senate; *Gerousia*, or Comitia; and *Boule*, or Town Council; but generally from civic adulation the court of the imperial family appear on the coins. The reverses resemble the Roman, but present great variety of type, and are executed with less taste. Their inscriptions are remarkably copious. Their monetary system assimilated itself to the Roman by issuing large brass obols, and medium and smaller sizes to imitate the Roman bronze currency, but the pieces are generally flatter, and the relief lower, and the weight less. The coins of the few Roman colonies have been alluded to, and fall into this system; they struck permissu Augusti or Proconsulis, by the permission of Augustus or the Proconsul, but were soon suppressed, or converted into imperial mints.

From the coins of the Greeks the natural transition is to the currency of Rome, from which the present monetary systems of Europe have been derived.

Although little has been recorded about the condition of the Greek mints, rather more is known of the Roman. The asses were originally cast, *flavissæ*, but towards the close of the republic were struck; the dies are supposed to have been of hardened brass, the blanks were cast, and then cut or separated at the gate of the mould, they were then placed with the forceps on the anvil, and struck between the dies by the hammer; occasionally a coin, not having been withdrawn, the next piece was *impressed* with the incuse or intagliotype, which as it is the obverse, shows that the obverse die was uppermost. The mint itself was held in the temple of JUNO MONETA, or "the Adviser," and the following officers presided over it,—the questors, the triumviri monetales, or triumvirs of the money, to whom Julius Cæsar added a fourth, and who appear B.C. 289, the director, *optio*; assayer, *exactor*; caster, *flator*, *flatorius*; the placer or feeder, *suppostor*; the striker, *malleator*; and the engraver, *scalptor*; the *officinator*, workman, and *nummularius*, treasurer, and *coenarius*, purifier. They formed a corporation; under the republic the workmen were public slaves, but Cæsar appointed freedmen, and the Gothic kings of Rome elevated the social position of the mint masters. The triumviri monetales presided over the issues of all three metals, but the brass continued under the empire to be struck by decree of the senate, while the emperors alone had the right of coining gold and silver, and had their money separate in the treasury (Dio. liii.), which was superintended by the Præfectus Aerarii, or the Procurator in the later times of the empire. In Rome itself the whole establishment was under the Præfectus urbis, in the provinces under the Præsides, and under the barbarian kings of Rome under the mayor of the palace. Bronze dies of the empire have been found.

At the earlier times the Romans had no gold coins, but used the Philippei, or Macedonian stater, a term retained under the later empire ('Lactantius,' i. c. 6; A.U.C. 546), the gold *aurei* were first issued sixty-two years after the denarii. The earliest aurei are supposed to have been coined B.C. 207, and some writers have supposed that originally 48 were struck from the pound of gold till 134 B.C.; 45 from B.C. 134-119; 42, B.C. 119-104; 40, B.C. 104-37; 41, B.C. 37-14 A.D.; 40 under the early emperors till Nero's reign, who issued 45; 50 under Caracalla, 60 under Diocletian, and 72 under Constantine. The aureus was called like the silver coin *denarius*, but weighed 2 scriptulæ, or double the weight, and was worth 25 silver coins, and 100 sesterces or large brass pieces called nummi, with some fluctuations. The half aureus or Roman half sovereign was called quinarius at a later period. This was for greater public convenience, the taxes under the empire being paid in gold into the treasury; and under the Byzantine emperor, Alexander Comnenus, the payments of the state issued in copper. The right of striking gold as well as silver belonged to the emperor alone, and it was an act of treason for a subject to place his image on the coin, or even to show the least dishonour to the imperial portrait or effigy, which was considered inviolable. The types of the earliest gold and electrum coins of the Romans, struck in Capua about B.C. 210-180, have on the obverse the head of Mars, or Janus, and on the reverse Roman deities. They are marked behind the head with their value in sesterces, the piece of XX sesterces weighed a Roman scriptula, or scruple, 18·06 grs.; that of XXX sesterces; of XXXX sesterces; and ↓X (lx) sesterces, in proportion. Pieces struck by Sylla and Lucullus, called Lucullians, weighed 10 scriptulæ, or 165 grains. Pieces of larger size and heavier weight than the aureus are called medallions, and are supposed to have been issued as medals for the legions. Elagabalus is said to have struck denarii of double, treble, four, and a hundred times the usual size, and even to the weight of two pounds, but such vagaries were destroyed after his downfall. Alexander Severus struck halves called semisses, and thirds, tremisses, to accommodate the remission of taxation to one-third. After the time of Constantine the gold coin was called *solidus*, and victoriatus, from the recurrence of the figure of Victory on the reverse. Towards the close of the republic, the aureus was sometimes of electrum, or ⅕ silver, and under the Lower Empire of obryzum, or gold mixed with copper or rouge. It was generally very pure; at the time of Vespasian, its purity had $\frac{1}{788}$ only of alloy. The proportion of gold to silver was as 1 to 10; B.C. 189, 1 to 9; B.C. 54, under the Empire, as 1 to 12; and as 1 to 14 or 18 from Constantine to Justinian.

The original aurei were 130.1 grs.; under Pompey the highest reach 128·2 grs.; under Augustus they sink to 121·26 grs.; those of Nero have 115·39 grs., and they continued at the same weight under the Empire. Constantine struck 72 to the lb., each weighing 68·5 grs.; these were worth 12 silver milliarenses, and were divided into semisses, tremisses, and quadrantes.

After the victory of Livius Salinator over Asdrubal, A.V.C. 545 = B.C. 209, the Romans issued silver coins weighing about 62 grains, on the model of the attic drachmæ. These coins were called *denarii*, or pieces of ten asses; *argentei*, silvers; *bigati*, having a two-horse chariot or *quadrigati* with four. They are about the size of a sixpence, but thicker, and are the Roman *Franc*. Foreign silver *drachmæ* were in circulation at Rome previous to their issue. A long succession of these silver pieces consisting of some thousand varieties from this period to the age of Gallienus, form the Roman silver, divided into Consular, or those struck under the Republic, and Imperial, or those from the time of Augustus. The earliest denarii having on one side the head of Rome, and on the other the Dioscuri, can be traced to B.C. 224, and 219. The earlier denarii have X or XVI. (16 asses) stamped behind them for their value, and ROMA on the reverse; the quinarius or piece of 5 asses about the size of a silver fourpence, has V. behind the head of Mars, and on the reverse a Victory, the sestertius of the size of a silver penny has HS. behind the head. These pieces and marks were discontinued about the first cent. B.C. The tradition that Servius Tullius struck silver money at Rome [Varro in Chariso lib. I.] deserves no attention. The tribune Livius Drusus, sanctioned the alloy of ⅛ of copper, and Antony allowed iron, but the debasement of the currency was restrained by the Gratidian Edict and the Cornelian Law. The denarii however continued tolerably pure till the time of Severus, although a slight corruption commenced with Didius Julian; their mean weight is 60 grs. Under Nero 7 denarii were coined from the Roman ounce of silver, later 8, and even more; denarii equal to 1½ of the usual size and weight, or six sesterces, and called *argentei*, were struck by Caracalla, of a debased silver besides the usual size, the silver being half debased. Alexander Severus who reduced the taxation by one third, debased the silver in the same proportion by ⅓ of its purity, but at the time of Valerian and Gallienus a national bankruptcy ensued, the denarii were debased to billon, of ⅕ silver, the brass sesterces and dupondii, nummi incoctiles, 1st and 2nd brass were suppressed. Aurelian made 525 of these base pieces equal to the *aureus*, by issuing a denarius of account equal to 20 or 21 of them, and marked XX-XXI–XXIV. From Claudius Gothicus to Diocletian, the denarii were of brass washed with silver the *nummi tincti*, and the successors of Constantine to prevent forgery of the public money made the denarii thinner and of larger size. Diocletian issued silver pieces of 48 grs., the *cententionales* or 'hundreds' marked XCVI, to show the proportion of alloy, 4 per cent. in the lb. of silver, with the denarius of 62 grs. Constantine added to the silver currency the *miliarenses*, or *miliarisia*, of 84 grs., 12 to the solidus, and the *siliquæ*, or *keratia*, of 42 grs.; but 5 different denominations of his coins are known from their weight, and the confusion of the monetary system after and about his time baffles research. At the close of the Lower Empire they became very thin concave pieces of metal, the nummi scyphati, and the whole system of currency was altered.

The earliest Roman coins were of brass, *æs*, and heavy pieces *æs grave*. But there is great discrepancy about the time when it was introduced. Saturnus is said to have introduced it, and divided the solidus or pound into the semis or half pound. At the time of Servius Tullus, brass went by weight at Rome. (Timæus, in Plin, xxiii. c. 3.) Numa issued leather money *scortei*. Menenius Agrippa is said to have been buried by a subscription of sextantes, and the people subscribed quadrantes or farthings for P. Valerius. But the brass coinage of the Romans appears to have been derived from the Etruscan currency, and cannot be earlier than 353 B.C. The oldest currency was cast, not struck, and said to be impressed with an ox or sheep. (Varro, 'I. Vit. Pop. Re Rust,' lib. 2.) The following pieces have been found of the early series:—a decussis, having the head of Pallas, reverse a ship, weighing 38 Roman ounces; the quincussis impressed with two dolphins and two tridents, reverse, two chickens and two stars = 4 lb. 8 oz. Roman; a quadrussis, on each side an ox, of 5 lb. 6 oz., and 4 lb. 3 oz.; a *tripondios* of 3 asses marked III. head of Pallas, reverse a ship, for an as of 3 ozs., head of Pallas and sword. The types of the rest of the currency are quite uniform, the *as* has the head of the double Janus, the *semis*, the letter S. head of Jupiter, the *triens* ⁞ (4 ounces) head of Pallas; the *quadrans* or farthing ⁝ (3 ounces) head of Hercules; the *sextans* : (2 ounces), head of Mercury, the ounce · head of Pallas, all have on the reverse the prow of a ship, alluding to the arrival of Janus or Saturn in Italy, and boys instead of crying heads or tails when they tossed for money cried heads or ships. Ases of 11 lb. 5 oz. exist, many of 3 and 4 ozs. showing that the reduction was gradual: after the 1st Punic war the *as* was reduced by the Lex Papiria to 1 oz., and to ½ oz. from the time of Sylla to Pompey. (Cohen, 'Descr. gen. domnn. de la Rep. Rom.,' 4to. Paris, 1857.) At the commencement of the Empire the names of the triumviri monetales were stamped on the coins; the *as*, the second brass coin, was struck of copper, the sestertius or first brass coin was struck of the Spanish orichalcum, and at the time of the Flavii the æs flavum was of copper mixed with brass; the third brass coin, the quadrans, copper; the earlier bronze coin are alloyed with zinc, and lead was not introduced till the time of Severus.

I. The largest Roman brass coins after the fall of the Republic are the so-called first or large brass, the sestertii. These pieces were in use from the days of Augustus to Gallienus. Under the thirty tyrants they disappeared, but a new piece was issued by Diocletian called the follis, 24 of which went to the silver miliarensis, and each was half an ounce in weight and worth 40 noummia or small centimes. In the Augustan age it weighed nearly a Roman ounce, but it declined in weight under the later emperors, under Severus Alexander was one-third lighter, and reduced by Gallus to one-third of an ounce. Trajan Decius struck two—sextarii or quinarii of orichalchum. Originally it was struck from an alloy of copper and zinc, with a small quantity of lead, of which a greater quantity became introduced in the days of the Antonines. The types on the obverse generally present the portrait of the emperor, while the legends record his titles, how often he had exercised the consulship or tribunitian power, or been saluted emperor, by which the date of the coin can be determined. The reverse indicated the character of the reign, the deities, the virtues, the temples, sacrifices, consecrations, and apotheoses; the provinces, cities, rivers, ports, and bridges; indulgences, remission of taxes, and exhibitions of spectacles; the victories, harangues, expeditions, journeys of the emperor. The virtues being accorded by the adulation of the senate, and not by the censors of history, present the moderation of Tiberius, the clemency of Vitellius, and the triumphs of Domitian, and are fortunately corrected by the pen of the historian.

The size of the sestertius allows scope for the skill of the artist. From Augustus to Nero the style improves, and continues excellent from Vespasian to Hadrian. After Commodus, the art declines till the fall of the Gordians; and the subsequent pieces exhibit a remarkable degeneracy, especially at the time of Gallienus, the portraits only showing any merit.

II. The next size to these coins is the so-called second or middle brass, consisting of two metals and two different denominations: the *dupondius, dibella,* or half sesterce, struck in brass, and the *as* of pure copper. The dupondius underwent the same changes as the sestertius till the time of Gallienus, when it was suppressed, having been reduced by Severus Alexander to ⅔rds of its weight. This series is important for being more continuous than the large brass, few imperial portraits being wanting, and some being absolutely requisite to complete the first brass series, as Agrippa, Tiberius, Pertinax, and some others. At the time of Diocletian, the term second brass is usually applied to the follis of ½ oz. weight by collectors, and reappears from Aurelian to Anastasius, which circulated along with the brass denarius, first struck by Philip, equal to four sestertii.

III. This series consists of Roman semisses and quadrantes, although some have erroneously regarded them as the uncia. They are pieces issued by the moneyers under Augustus and Tiberius, and reappear under Caligula with imperial portraits, one of the finest being that of Nero; it is common under Domitian, Hadrian, and the Antonines, after which it disappears till the age of Decius. The greatest portion of the series, as arranged in cabinets, comprises the base denarii issued by Gallienus and the thirty Tyrants, down to the reign of Diocletian; after which period it is profusely abundant in types and varieties, and becomes the assarion under Diocletian and his successors, disappears with Julian III., and ceases to be distinct in the divisions of K. 20, I, 10 *noummia* of the follis. A complete series in 3rd brass is impossible, as no pieces of this size exist from the age of Hadrian till Gallienus. Many of the earlier specimens were struck by the moneyers, and several have no imperial portraits, but only heads of deities and SC. on the reverse; and with them the quadrantes, issued from the mines of Noricum, with the inscription METAL, are generally classed.

Coins of a larger size than the ordinary currencies have been called medallions, a word derived from the Italian *medaglione,* again derived from the Greek *metallon.* The decadrachms of Athens and Syracuse have been thus called, but the term is more properly applied to the large pieces of the Roman series. Some few of gold and silver occur under the upper Empire, but silver medallions are most prevalent after Constantine; one of the most remarkable and the heaviest being that of Priscus Attalus, in the British Museum. After the time of Hadrian, bronze medallions, heavy and thick pieces, struck by the emperor without the authority of the senate, and made of two metals appear. These are the ancient *missilia,* so called from being hurled into the amphitheatre. They are sometimes made of two metals, the outer portions for ⅛th or ¼ inch being of copper when the body is of bronze, or *vice versâ,* and are often found set in flat disks measuring 6 inches diameter, and forming part of the standards of the manipuli and vexillations, being with the busts part of the sacred effigies placed in the chapels of the legions and adored by them. At the time of Severus they are often wholly or partially gilded, and sometimes ringed for suspension. They were also probably given as military rewards. These pieces are of great rarity and interest, but the subjects on them are the same or similar to the Roman first brass. They are ancient proofs or medals properly so called.

Another kind of medals are called by the numismatists *contorniati* "encircled," or *revocati,* and are about 2 inches in diameter. They are so named from a deep groove which runs between the legend and the border, often curtailing the letters of the legend, and the edge is generally flanged. Some rare examples have their subjects on both sides incuse. They have on the obverse the busts of deities, emperors, heroic personages, poets, or philosophers, and in the area the unexplained monogram P E, a palm branch, lion, and other symbols, punched or incised, and often inlaid in silver, and on the other figures groups and mythological subjects, probably copied from celebrated works of art then extant. A very prevalent type is that of a quadriga, alluding to the Circenses. Legends on the obverse refer to the bust represented; but many of those on the reverse are votive exclamations to charioteers or athletes, as VRSE VINCAS., OLYMPI NIKA., PETRONI PLACEAS. ("May you conquer, oh, Ursus! Olympius, conquer; Petronius, may you please"). They are supposed to have been struck from the time of Gratian, A.D. 375, to the reign of Anthemius, A.D. 472, the last emperor represented on them. The object for which they were struck is unknown, whether for throwing into the Circus, or presentation to successful charioteers. The portraits of Homer, Sallust, and Horace are found on them, but of late date and apocryphal character. These medals are often chased or imitated in the times of the renaissance. (Sabatier, J., 'Description Générale des Medallions contorniates,' 4to, 1860.)

Similar to the contorniati are a class of medallets of the size of the 3rd brass, having on one side numbers from i. to xxix., and on the other busts and other representations, chiefly of an indecent nature. These little pieces are called *spinthriæ,* and are supposed to have been issued by Tiberius, or for the Floralia. Others, of the same size, were also struck for triumphs, the Saturnalia, and other popular occasions, or even for quack doctors. With these may be also classed leaden pieces, used as seals, tokens, or tickets (Eckhel, 'Doctr. Num. Vet.,' viii. 314), such as are said to have been issued by Agrippa, Nero, Hadrian, and others, for largesses to the populace. Money was thrown on great occasions into the arena of the circus and amphitheatre, gold being restricted to the emperor, while the consuls were only allowed to throw down silver.

The types of the Roman coins differ considerably from the Greek, commencing at a period when the arts were in a rapid state of decay, and the treatment more pictorial, as is shown by the numerous figures often introduced upon the reverse. While, too, the Greek autonomous coins represent deities, or animals, and emblems, the Roman coins assume an historical character, and abound with allegorical figures of mental qualities, as *spes,* or hope; *patientia,* patience; *providentia,* prudence; *fides,* faith; *lætitia,* joy; while liberality, peace, honour, virtue, fortune, and the like, are portrayed by their respective figures; besides which, the principal deities of the Pantheon are represented, or public events as they appeared at the time, as prostrate princes, legionaries at the adlocutions or addresses, and the sacrifices of the Decennalia, the emperor on horseback in his decursio, and the various public buildings represented in a conventional manner. These are often accompanied with inscriptions recording the name of the deity or allegory represented. The types of the Roman coins are in fact more pictorial than Greek, but not so much so as modern medals, on which numerous figures and aërial perspective are introduced.

Besides the usual types, occasionally smaller impressions stamped from punches are found on coins. On the autonomous Greek series there are generally the types of other states, and were impressed to give the pieces currency in their territory; sometimes as many as three have been found on one coin, as ΠΕΡ for Pergamus, ΤΡΑΛ for Tralles, ΣΑΡ for Sardes. In the Roman series they appear as brands, the emperors countermarking the coins of their predecessors; while other marks, such as S C., S P Q R., seem to indicate that the effigy or coin was cancelled. Besides these letters, and other marks, the defacements of possessors are found; but these are in letters incised, not in relief. At Rome, countermarks commence under Augustus and continue till Trajan, reappear in the Lower Empire under Justinian, and are found as late as Anastasius. Some marks are supposed to have been impressed by the *exploratores monetæ,* as PR, M.PR, and BON, to indicate *moneta probata, probata,* approved, *bona,* good or passed, coin.

The inscriptions on the Roman coins are much more copious than those on the Greek autonomous. On the consular series they have the names of the personages represented, and the triumviri of the mint. On the imperial coins the inscriptions on the obverse have the name and titles of the emperor, which are sometimes continued on the reverse. These have the abridgments common to Roman inscriptions, as IMPerator, CAESar, AVGustus, COnSul; D. N., dominus noster; P. F., Pius Felix; P P., Pater Patriæ; TRibunitia POTestate; or TR. P., the same. The reverses of the bronze have always the S. C., referring to their being struck by Senatus Consultum, which is to be distinguished from the EX. S. C., showing that the type referred to some act of the senate. The other contractions are too numerous to be given, but REST. refers to the restoration of certain coins made by the emperors, either of the pieces coined by their predecessors or ancestors. The subject of the reverse has often a full inscription, as ÆQVITAS., SPES., AQVA TRAIANA, explaining the figure, but at the time of Philip single letters appear in the area of the coin, and seem to be the initial of the names of the mint, the first hitherto referred being those of Tarraco and Siscia on the coins of Probus. From this period till the close of the Byzantine empire they are constantly placed in the exergue, generally preceded by the form P., percussa, or pecunia, or S.M., sacra moneta, as S M A N Γ., sacra moneta Antiochensis tertium; or M-oneta only.

The principal mints are, ALexandria, ANTiochia, AQuileia, ARelatum, CONstantinopolis, LONdinum, LVGdunum, OSTia, TReviri, THEVPolis. The Latin mints have the initials of numerals indicative of their sizes, offices, or issues, and the Greek have Α.Β.Γ.Δ. for the same. From the time of Probus, XXI. the number of these pieces which went to the denarius are marked, and on the gold after Constantine OB, the Greek for 72 occurs on the solidus, after the name of the mint. Only one date of the A.V.C. DCCCLXXIV. is found on the Roman series. Some blunders occur, either the work of forgers or the result of official carelessness, as Consecrautio for Consecratio, Mletam propugnatorem for Martem propugnatorem, Ianum Clusti for Clusit, Sousti for Faustina.

As the triumviri monetales could not impress upon the public money their own effigies, they placed upon it the most memorable events of their family history, and hence the aurei and argentei of this series present several remarkable types. The brass coinage is less interesting, the as has the head of Janus; the semis, Jupiter; the triens, Minerva; the quadrans, Hercules; the sextans, Mercury; the uncia, Minerva or Juno. All have the ship on the reverse. Those with the names of the triumviri monetales present no more interest. The older types of these denarii have the head of Rome on the obverse, and on the reverse a four-horse chariot, whence they were called quadrigati, or one of two horses, bigati, or the Dioscuri on horseback. Later types have on the obverse the heads of deities, personifications, as Piety and Fear; historical personages, as Numa, Ancus Martius; or contemporary portraits as Ahenobarbus, Julius Cæsar, and others. The reverse presents many interesting types, allusive to the names of the triumviri by whom issued, as Clymene and the sisters of Phæton transformed into *larices*, or pines, on the denarii of P. Accol., *Lariscolus*; Perseus and his family chained before Paulus Æmilius, B.C. 167; M. Lepidus placing the diadem on the head of Ptolemy V.; Aretas, King of Arabia, descended from his camel, offering the olive-branch to M. Æmil. Scaurus, A.D. 62; the sacrifice and treaty with the people of Gabii, in the reign of Tarquin the Proud, on the Antistia family; the standards or legions of Antony, on the denarii of the Antonian; Scipio, on the Cæcilian family; the head of Numa on the Calpurnian; the victory of Cassius, the conspirator, against Cæsar; at Cos over the Rhodians; M. Cl. Marcellus depositing the Spolia Opima of Viridomarus, in the temple of Jupiter Feretrius; the Temple of Venus Erycina on the Considian; Sylla, Scipios, and Lentulus; Sylla seated on a suggestum, holding a laurel between Bacchus and Jugurtha; Marius mounting his triumphal car, on the coins of the Fundanian family; the coins of the Julian family refer to J. Cæsar; J. Brutus, and M. Brutus appear on those of the Junian family; the ancilia, on the Licinian; the rostrum on the Livineian family; on the Petronian, Tarpeia overwhelmed by shields; and on the Plautian, the surrender of Bacchius Judæus to A. Plautius; on the Pompeian, the Pharos of Messina; Porcia, the right of appeal to the tribune, with the legend "provoco," and name of M. Cato; Scribonia, the celebrated Puteal.

In the imperial series the most remarkable can only be cited. Those of Pompey, J. Cæsar, Brutus, Cassius, Lepidus, and Antony, and even many of Augustus belong to the imperial series, and the cistophori. Of Livia there are 2nd brass with Pietas, and denarii, with her head and those of C. and L. Cæsar; the coins of Agrippa are principally consular, except the 2nd brass, his sons C. L. Cæsars, appear only on aurei. The gold, silver, and 1st brass of the elder Drusus are rare, and the types refer to his German victories; Tiberius, is rare in 1st brass. The younger Drusus is seen on denarii and 1st brass, and his twin sons on a dupondius, their heads rising out of a cornucopia. Those of Germanicus (B.C. 15 to A.D. 14), B.C. 17, refer to his German victories. The elder Agrippina is found chiefly as the reverse of Caligula, who also struck dupondii of Nero and Drusus his brothers. The most remarkable of Caligula are the large brass, with Agrippina, Drusilla, and Julia, his 3rd brass have the cap of liberty, alluding to the right of voting conceded by him to the people.

Claudius has aurei and denarii, alluding to his reception in the Prætorian camp, and his triumph over Britain; his large brass, with *Spes*, Hope, on whose festival, 1 Aug., he was born; and of the younger Agrippina denarii, with her apotheosis. Nero has coins of remarkable beauty, especially large brass, with the decursio, congiarium, macellum, Adlocutio, and Portus Ostiensis: his 3rd of the Quinqunenalia or Neroneia. Of Claudia, his daughter, there are 3rd brass. Of the revolted Clodius Macer, there are rare denarii. Of Galba, the most remarkable reverse is the Hispania. Of Otho, there are aurei and denarii, but no Roman brass. The most remarkable coins of Vitellius are those referring to the consultation of the Sibylline books by the quindecimviri, and the portrait of C. Vitellius. The most interesting types of Vespasian are those with Judæa Capta. Of his consort Domitilla, are large brass struck to her memory. None of Titus are remarkable, his daughter Julia appears on denarii and aurei. The most remarkable pieces of Domitian are the large brass with Germania Capta, and the denarii with type of the Saecularia. The large brass of Domitian are rare.

Of Nerva, the Fisci Judaici calumnia sublata, on the remission of the poll tax of two drachms for the rebuilding of the Capitol, and the Vehiculatione Italiæ remissa, on the remission of the impressment of means of transport for the army of Italy, are singular. Trajan has a numerous series, with the types of Dacia Capta, the Danubius, the Arabia adquisita, A.D. 105, the Armenia and Mesopotamia in potestatem reducta—the Via, Aqua, Trajana, and Basilica Ulpia. Rare, but uninteresting are those of Plotina Marciana, A.D. 114, and Matidia. Hadrian, A.D. 117-138 has an interesting series of the personifications of the provinces which he visited. Those of Sabina are rare, and of Aelius Cæsar has large brass with Panonia; Antoninus Pius, the Provinces—the sow with thirty pigs, the Mars Pendens; of Alexandria, Faustina, and M. Aurelius, the types are uninteresting; so are those of Faustina II., Annius Verus, and L. Verus, and Lucilla. The large brass of Commodus record his attempt to call Rome the Colonia Antonina Commodiana, and his assumption of the title of Hercules; Crispina, his wife, has types of the conjugal gods, and Pertinax pieces dedicated to Janus and the Mind. Didius Julian, Manlia Scantilla and Didia Clara are rare. Pescennius Niger struck only aurei, and denarii in Antioch. Clodius Albinus was killed for assuming the title of imperator on his coins. Severus has types referring to the war in Britain. Caracalla, difficult to distinguish from Elagabulus, has only his Circus. Plautilla and Geta struck in 2nd brass only. Macrinus, Diadumenianus are common; of Elagabalus, Sol Elagabalus, his eponymous god, are alone interesting. The types of his wives, Cornelia Paula, Aquilla Severa, Annia Faustina, and Julia Sœmias, and Mœsa, are unimportant. Of the numerous types of Alexander Severus, one refers to his restoration of the coinage. Maximinus and Maximus are unimportant. Those of the elder Gordian and Pupienus and Balbinus are of great rarity, but of Gordian III. none are remarkable; but those of his wife are of the greatest rarity. The coins of Philip I., II., are chiefly remarkable for the commemoration of the Sæculares, and the figures of the rare animals seen in the Circus on that occasion. His wife, Otacilia, is rare in gold.

Trajan Decius bears Pannonia; Pacatianus, Etruscilla, and Herennius Etruscus, are rare: the large brass of Trebonian Gallus have Juno Martialis. The gold and brass of Æmilian, of Volusian, the silver, and small brass of Cornelia Supera, and brass medallions of Valerian are rare. Mariniana, Gallienus, Salonina and Saloninus are common and uninteresting. The Gallic usurper, Posthumus, has some peculiar types of Hercules. After his reign, with the exception of one type of Aurelian, the large brass disappears; some of the later pieces are the aurei of Magna Urbica, and of Julian II. Diocletian reformed and issued numerous pieces in all metals. Maximian I. is common, but the aurei of Carausius and Allectus, A.D. 287-93, are of a rarity almost unique, and struck in the mint of London. Under Constantius Chlorus Severus, Maximin II., Maxentius, Licinius and Constantine the type became monotonous, and Constantine, A.D. 306, 307, has a long series, some referring to the building of Constantinople and Rome, and others with the monogram of Christ.

From the time of Constantius and his family the reverses become more uniform. The Emperor assumed the title of D. N. or Dominus noster; the types of the reverse are principally Victories holding wreaths, legionaries with ensigns with Gloria Exercitus and a horseman spearing a fallen enemy, the *Felix temporis reparatio*, while the Cæsars are represented as the Princeps Juventutis, and the vota quinquinalia, decennalia, and vicennalia and a few other ordinary types. Of Constantine II. are 3rd brass with victories of Constans I. Victor omnium gentium and the Bononia Oceanensis or Boulogne-sur-Mer, with a galley, referring to his expedition to England. Constantius II. is common. Nepotianus, A.D. 350, is found only in 2nd brass, Vetranio at the same date, has an eques with the Labarum and Hoc signo victor eris. Magnentius, Decentius, and Constantius Gallus are uninteresting. The reverse of Julian III., 360, abound with the Isis Pharia and Deus Serapis. There is an unique solidus of his wife Helena. The types of Jovian, Valentinian I., Valens, Procopius, Gratian, Valentinian II., Theodosius, Flacilla, Maximus, Victor, Arcadius, Honorius, Constantius III., Placidia, and Jovianus are not remarkable. Of Priscus Attalus, A.D. 409, there is a unique medallion with Rome and "Invicta Roma æterna;" and the emperors with "Bono Reipublicæ nati," Theodosius II., Eudoxia, Johannes, Valentinian III., and his successors till Romulus A.D. 475, offer no interest. In the Byzantine series the reverses of Justin I. have the names of Theodoric and Athalaric; those of Justinian are uninteresting. The portraits of the emperors wear embroidered dresses, the dalmaticum, with crowns on their heads, and globes and crosses in their hands; and crosses on steps for the reverses of the solidi commence. A series of Gothic kings commence with Theodoric, A.D. 489, and end with Baduela, A.D. 552, the last with the reverses of Floreas Semper and Felix Ticinus; and of Vandal monarchs, Gunthamund, Gelimar, and Theodebert offer no great interest. From the time of Justinian the copper pieces have on the reverse the numerals of the follis, its subdivisions, the year of the reign, the place where minted; the inscriptions are in cursive Latin and Greek. Johannes Zimisces, A.D. 969, placed the full-faced image of Christ, the Virgin, and the Holy Sepulchre on his coins. The *numi scyphati* commence with Constantine XI. and the series ends, A.D. 1448, with a doubtful coin of Constantine XIV. or Palæologus.

The prevalence of forgery at an early period is shown by the severity of the laws of Solon which punished the crime by death; and by the fraud of Polycrates, who paid the Spartans with coins of lead plated with gold. Plated Greek coins in silver of the earliest period, as the didrachms of Themistocles, in Magnesia, and the incuse coins of Magna Græcia of the 7th century, B.C., and gold darics, electrum staters, and tetradrachms of cities and kings have been found. So numerous are the false consular and imperial denarii, that they seem to have issued from the public mint, and so extensive was the evil, that public gratitude erected statues to M. Gratidianus, who had passed a law against the practice, severely punished by the Lex Cornelia. Plautus, and Martial mentions *nigri*, base *plumbei* or lead coins made of this metal covered with a thick plate of other metal and then struck from a die. The false silver and gold are detected by having wrong reverses, blundered legends and types, and defective weight. The emperors, especially those who paid large donatives to the troops, appeared to have issued plated coins *numi subærati*, or *pelliculati*, and Caracalla is expressly stated to have done so. It is supposed that the coins with dentated edges, the *serrati*, were struck, to prevent this fraud; but the forgers imitated even these. These forgeries began to be collected as rarities in the days of Pliny, and these ancient forgeries are no less prized by collectors than those in purest metal. During the middle period of the Empire the forgers used flat circular moulds of fine clay moulded from true coins, each counter having an obverse on one side and a reverse on the other, stacked them in vertical rouleaux, luted them all in a triangular mass, and poured in the fluid billon or potin. Crucibles, moulds, and other tools of these ancient "smashers" have been found in England, France, and Germany, and Egypt. The forgers continued their operations notwithstanding the severity of the laws, which condemned freedmen who committed the offence to the beasts, and slaves to a torturing death; and Constantine punished false coining as high treason with the penalty of confiscation, exile, or death, and reduced the thickness of the coins so that it might ring and prevent plating.

After the fall of the Roman Empire the separation of Europe into various small states gave rise to a currency like the autonomous coins of Greece. It is not possible to give a detailed account of the numerous types found in the modern series which has existed in Europe for the last 1400 years. The first French dynasty, the Merovingian, issued sous d'or, (solidus), demi-sous (semis), and tiers sous, trientes, struck by the great lords or moneyers, with their names and that of the mint, and imitating the coins of Anastasius. Under the Carlovingian dynasty deniers of silver were introduced, and the sous d'or almost abandoned, and Charlemagne introduced his name in a monogram on the coins, A.D. 864. The dissolution of the empire of Charlemagne gave rise to the Italian and German series. During the commencement of the Capets the denier tournois with a Tower and Parisiis, and oboles were chiefly in circulation. The royal portrait did not appear till Louis XII., and Anne of Brittany first placed the millesime or date of the Christian era on the currency in 1478. Besides the regal coins, the barons, bishops, and monasteries issued their own currency; but these were gradually suppressed by the crown. In the series there are a few bracteates, or thin coins of a leaf of gold or silver, struck in relief on one side and hollow on the other, and issued by religious houses, and *mereaux*, tokens, which under some circumstances were used for coin. The coins of Germany follow the French style; but the art is not so good. The early coins of Bohemia resemble the Anglo-Saxon: later ones have St. Wenceslas. Those of Hungary commencing with the 11th century, A.D., have the effigy of the monarchs. The coins of Poland commence with Boleslas the Great, imitate the Anglo-Saxon types, and have the portrait of the monarch. The early currency of Russia consisted of furs and coins; gold coins do not begin till the 10th century, A.D. They are imitated from the Byzantine currency; the silver, called *denga*, begin with the 14th century, are of oblong shape with the prince on horseback, Samson and the lion, Arabic legends; copper commences about the 15th century, and Peter the Great introduced the usual European types in the 18th century. In Italy the coins of the Gothic were succeeded by the Lombard kings, and those of the dukes of Benevento and Salerno, the Norman princes of the kingdoms of the two Sicilies, all imitated from the Byzantine currency; and the currency of Charlemagne, who forced the tributaries to adopt his monogram on the coins. At Rome, from the 11th to the 14th century, the currency was issued by the Senate till Innocent IV. regained the power; but as early as the 13th century the Pope coined in the Legations. From the 9th to the 11th century the prelates of Manheim, Aquileia, and Ascoli struck their own coins. A series of coins of Venice, comprising *sequins* and *gazettas* commence with the 12th century and terminate in the 19th, having for their normal type the Doge receiving the gonfalone, or standard from St. Mark. From the 12th to 14th century the Republic of Genoa and other free towns struck coins. Malta, given in 1551 to the Knights of St. John of Jerusalem, has a series with the arms and effigies of the Grand Masters.

The modern coins of Spain commence with the Visigoths, who entered it in A.D. 581, who struck a series of gold solidi imitated from the Byzantine, with their heads and those of the emperor on the reverse. The double heads disappear about A.D. 650, and give place to profile portraits, the monogram of the king's name, and the crown. The coins struck by the Mussulman princes belong to the Oriental series. The kingdoms of Castile, Arragon, and Majorca follow the usual mediæval types. The coins of Great Britain and Ireland have been already described [Coin]; the early pieces of Denmark, commencing with Harthacnut, A.D. 1036, resemble them. But from the end of the 10th to the 12th century numerous bracteates were issued, many by ecclesiastics; and crosses are the normal type from the middle of the 13th century, and crowns after 1280. In Sweden, the early types of the 11th century copy the Anglo-Saxon; but from the end of the 11th to the 14th century a great number of bracteates, and small pieces with the initials of the king's name, were in circulation. From 1365 the coins bear the arms of Sweden and the three crowns. The coins of Norway commence at the same time as those of Sweden, but are less interesting. Of the Crusaders, there are large bronze coins commencing with Tancred, 1110, and continuing with the various princes and nobles established in Greece and the East to the 15th century. The general series of types in the dark ages are imitations of the Byzantine—crosses, portraits, figures of saints, and heraldic emblems. The various changes and different values of modern coin belong rather to money than numismatics. Although, in reality, mediæval coins are much rarer than the Greek and Roman, they are less prized by amateurs, and few cabinets of them have been formed.

The Oriental coins comprise those struck in the East by the Mohammedans; these coins are flat thin pieces, like the later Byzantine pieces, and are called dirrhems. They commence with the Ommiah race of khalifs, the earliest being the gold dinars of the 78th and the dirhems of the 79th year of the Hegira. Both sides are covered with inscriptions in the centre surrounded by a legend, the whole recording the Profession of the Faith, varied by extracts from the Koran, the name of the city and year in which they were struck. The coins of Seljuks have the sun in Leo; the Turkoman Ortokites and Atabegs, portraits and devices rudely copied from Byzantine and other sources. The Mamluk Bahrites have occasionally a lion, in addition to their legends. The Norman kings of Sicily have mediæval types with Arabic legends. The later Turkish are distinguished by the *tograh* or complicated signature of the sultan. Some of the Persian have animals, as a fish, cock, camel, deer, and ox, in addition to inscriptions. The Patan dynasty, the kings of Jaunpur, have inscriptions only. Of the Moguls of Hindustan there is a fine series of gold mohurs, having on their obverse the twelve signs of the zodiac, struck by Jehangir in 1611. Of the sultans of Mysore, the most remarkable are the copper coins of Tippoo Saib, with an elephant. The earliest Hindu coins are those of the Gupta line, representing Brahminical deities. The coins of Southern India, Nepal, Assam, and Rangpur, have legends only. Of Tenasserim, there are large octagonal and circular tin coins, impressed on one side with a dragon and phœnix. The coins of China and Indo-China consist principally of the *tsien* or cash; but at the earliest period in China, copper knives (*taou*) and cloth-shaped pieces (*poo*) were in use. The cash have the value from A.D. 120, and the imperial name from A.D. 457; four characters, two meaning money, from A.D. 618. Under the Mogul and Manchou dynasty they have the name of the mint in Manchou on the reverse. There are only silver dollars of 1683, struck on the conquest of Formosa. The coins of Japan are flat gold plates called *obang* and *kobang*, and submultiples, the square *itzeboo*; the silver coins are flat rectangular pieces—*monme*, *gium*, and *nandiogiuns*; the *seni* cash like the Chinese, from 1636. The coins of the Corea date from 1116; of Annam, 1428; of Cochin, and Tunkin from 1740; of Java, from the 13th century, with Buddhistic figures to imitate the Chinese. Of Siam there are bent pieces of silver, stamped at the bend with ornaments.

The high prices paid for ancient coins gave rise to numerous forgeries in the 15th and 16th centuries, and many Italian artists, comprising Benvenuto Cellini, Valerio di Vicenza, Sebastiano Piombo, and others, especially G. Covino made false dies of Roman coins with great success, and issued the forgeries recognised as Paduans or Parmeggians by collectors. These, principally large brass, are detected by their thinner and rounder shape, closer and finer letters, and Italian style of work. Others retouched casts of true coins with the graver, and added a false patina, filing the edges. In the 18th century, Congornier, at Lyon, made gold coins of the Tyrants of the age of Gallienus, and La Roche and Devrieu at Florence, counterfeited the Roman large brass. Webber, Galli, and Caprara of Smyrna, are known as forgers of Greek coins. The forgeries of Beckker of Offenbach, who died in 1830, are by far the most numerous, consisting of upwards of 600 dies, and 331 pieces, and worth 2629*l.*, copied from the antique, principally in gold and silver, with some mediæval specimens distinguished by a coarser style of work, ignorance of details, expression, and letters. Greek medallions and coins were made by Neapolitan forgers, and false dies were in activity in 1830 at Syra. As few, if any of the Greek and Roman coins are found from the same die, the comparison of suspected struck coins in various cabinets, leads to the detection of forgeries of this class, in addition to the precautions of weighing the suspected pieces, and observing their correspondence with the standard and fineness of the true coins, to avoid which, however, Beckker often used for his blanks ancient coins of corresponding value.

The largest class of forgeries are casts made from antique coins, by making moulds of them in clay or plaster, and are executed with better success in gold and silver than in brass or copper, gold coins never having any ærugo, and the metal flowing more freely in the mould, and silver being easily oxydised by chemical agents so as to appear to have long lain in the earth, while the patina, or rust of bronze and copper, especially the *red rust* or protoxyde of copper, the hard crystalline character of which cannot be produced by chemical action, but only by the slow process, of centuries, *cannot be imitated*. All casts are deficient in weight, have smoothed edges, pitted fields, fused letters, and interstices more or less filled up, defects only to be concealed by the suspicious operations of filing the edges, tooling out with a graver the letters and features, and covering the whole with a false soft patina. The older deceptions of altering with a graving tool the portraits of common emperors into rare ones, tampering with the legends, or splitting two medals, giving rare and unusual reverses, of stamping different reverses or obverses, appears to have been abandoned, as too coarse to deceive, and are only found in old cabinets.

A coarser kind of forgeries were invented by the chasers and engravers of the 15th century, representing on one side the head of Priam, on the other a view of Troy, or Queen Dido and Carthage, Artemisia and the Mausoleum; such learned toys were, however, only calculated to deceive theoretical pedants. (Beauvais, 'La manière des discerner les Medailles Antiq.,' 4to, Paris, 1739; 'Sopra i Moderni falsificatori di medaglie Greche,' 8vo, Fir., 1820.)

Cabinets are generally made of mahogany, oak and cedar being objectionable owing to the turpentine and pyroligneous acid they exude. The drawers, ⅜th inch thick, are pierced with circular holes 1⅜ inch in diameter, for autonomous Greek, and 1⅝ inch in diameter for large brass; a small circular hole is left about ¼ inch in diameter, to allow of a coin being lifted by the finger, the holes are lined with movable pieces of cloth to prevent the rubbing of the coin. The larger and smaller sizes for medallions, silver pennies, dollars, and denarii are in proportion. As economy of space is always sought, each suite is arranged by itself, although the placing together of the entire currency of each people or monarch, irrespective of sizes or metals, is more instructive: Greek coins are arranged geographically; the Roman gold, silver, and brass each in a series, modern coins according to countries, the coins of emperors according to the states or cities where struck.

Although it is not possible to give in this article any account of the value of ancient coins, yet some notions may be given of the value of the coins of Greece. The gold staters of cities sometimes fetch 30*l.* or 60*l.*, those of the kings are comparatively common, and Philip II., Alexander III., and Lysimachus, are worth little more than their weight in metal, while one of Mithridates has sold for 120*l.*; in silver tetradrachms vary from a few shillings to many pounds—those of Athens, Alexander, and Lysimachus, being worth about 16*s.* or 20*s.*, while a fine one of Myrrhina obtained 260*l.* Those of the kings are generally rare, and many obtain as much as 30*l.* or 40*l.*; the unique one of Cleopatra, mother of Antiochus VIII., cost 240*l.* The copper is only very valuable when beautifully preserved. In the Roman series the consular pieces, and the Roman gold and silver are not generally valuable, a collection of the first being worth on an average 3*l.* 10*s.* per piece, and that of the latter not more than 5*s.* The large brass series is more valuable, the second much less so, and the 3rd brass of little or no value. The average value of a mediæval collection is about 15*s.* per piece, and of medals about 10*s.* Collectors will indeed find some clue to the price of Greek and Roman medals in the works of Mionnet and Cohen, but the values are constantly varying, and increase according to the preservation of the coins, and must be sought for by examining priced catalogues of sales. As a general rule, the prices paid for coins and medals have been much enhanced in the last quarter of a century.

Although it is not possible to give the value of any of the great public collections of Europe, some idea of their worth may be derived from that of collections formed by individuals. The collection of Dr. Hunter, now at Glasgow, cost upwards of 21,000*l.*, that of the late Mr. Thomas sold for 17,304*l.*, that of the Earl of Pembroke for 5905*l.* 14*s.*, and the late Lord Northwick's Greek and Roman collection realised 9138*l.* 14*s.*; that of the Duke of Devonshire, 6945*l.* 6*s.* 8*d.*

The rarity of ancient coins depends on various causes, but is principally owing to the few struck from a peculiar die, owing to the poverty of certain States, of the short reigns of some princes, or the suppression of their coins by public authority. Of some Roman Emperors there are absolutely none in certain metals and sizes; bronze coins of Otho, for example, were never struck by the Senate, and the coins of Caligula were called in and destroyed by the same body; but in all cases preservation enhances in the highest degree the value of coins otherwise ordinary.

Ancient coins are discovered in the bosom of the earth, or in the bosom of rivers where they have been lost or hoarded by public or private misfortunes. Isolated discoveries are constantly being made by excavators, but sometimes they occur in great numbers; 30,000 gold staters of Lysimachus were found in a river of the ancient Dacia, 30,000 silver denarii in 1760, at Brest, 4000 aurei at Hornoy, 12,000 pennies of William the Conqueror at Beaworth, and 7000 Saxon coins at Cuerdale, not to mention minor finds. They present different appearances according to the locality; gold under all circumstances retains its colour, but sometimes requires the removal of a crust of iron or other substances which adhere to it; silver is so oxydised as to present a grayish black colour, and for the types to be legible, it must be cleaned by lemon juice, citric acid, or acetic acid, and some use sal ammoniac. Bronze and copper present a most varied appearance; from the beds of rivers, such as the Thames, they have a yellow or brown patina, and only require removing from the matters which surround them. From volcanic soils they come with a bright turquoise blue or green patina, which must not be touched when it is polished, and shows under its coat, like the varnish of a picture, all the contours of the type and legend. The yellow and brown patinas of other soils must be respected, but the green gritty rust which disfigures many copper coins may be successfully removed by placing the coins in 1 part of hydrochloric acid with 14 parts of water, watching the progress, and allowing them to remain a short time afterwards in ammonia. The use of the wire brush, of the knife or graver, may be also judiciously applied to cleaning brass coins.

The principal general works on the subject are—

(Hennin, *Manuel de Numismatique Ancienne*, 8vo, Paris, 1830; Grasset, *Handbuch der alten Numismatik*, 8vo, Lips. 1852-53; Werlhoff, *Handbuch der Griechischen Numismatik*, 8vo, Hanov., 1850; Barthélemy, *Manuel de Numismatique*, 16mo, Paris. [no date.]

NUN. [Monachism.]

NUNCIO (*Nunzio*, in Italian; *Nuntius*, in Latin) signifies a messenger, but is used more particularly to designate the ambassadors sent by the pope to foreign courts. The nuncio is generally a prelate of the court of Rome; if a cardinal, he is styled "legate." Previous to the council of Trent, the papal nuncios in foreign countries acted as judges, in the first instance, of matters which were within ecclesiastical jurisdiction; but since that time they have acted as judges of appeal from the decisions of the respective bishops, in those countries only which are subject to the decretals and discipline of the council of Trent. In those kingdoms and states, such as France, which, though Roman Catholic, hold themselves independent of the court of Rome in matters of discipline, the nuncio has no jurisdiction whatever, and has merely a diplomatic character, like the minister of any other foreign power. (Père Richard, 'Bibliothèque Sacrée,' art. 'Nonce.')

NUNCUPATIVE WILL. [Will and Testament.]

NUTATION. [Precession and Nutation.]

NUX VOMICA, ALKALOIDS OF. The beans and bark of the nux vomica, and of several other species of the genus *strychnos* [Strychnos, in Nat. Hist. Div.] contain three alkaloids, namely, (1) *strychnine*, (2) *brucine*, (3) *igasurine*. It is to these alkaloids that the poisonous properties of the plants are due. In the beans of the *strychnos nux vomica* the alkaloids exist in combination with *igasuric acid*, but in the bark chiefly with gallic acid.

(1). *Strychnine.* ($C_{42}H_{22}N_2O_4$). *Vauqueline, Tetanine.* This alkaloid was discovered by Pelletier and Caventou in 1818. Several processes for extracting it from nux vomica have been described, but the following by Mr. Horsley is, perhaps, the most convenient yet published. An acetic extract is first made by kneading up the nux vomica powder with its own weight of commercial acetic acid; this is thinned out with five or six times its bulk of water, and the whole allowed to digest for a few days. The clear liquor must then be decanted off, and an equal quantity of fresh water poured on the mass and allowed to digest for a day or two longer, or till all soluble matter is extracted; the clear liquor is then decanted, mixed with the former liquor, and the whole evaporated to a syrupy consistence. When the resulting solution is cold, dilute with an equal bulk of water, add excess of liquid ammonia, and set by for a day or two that the strychnine may crystallise out. Next pass through a calico filter to separate the dark green mother liquor, and digest the resinoid residuum in hot dilute acetic acid and filter. The strychnine and brucine may now be precipitated by solution of potash, or the strychnine only by the addition of solution of chromate of potash, when a chromate of strychnine will be obtained free from brucine, provided the liquid, which retains the brucine, be tolerably acid. Chromic acid may be readily separated from the strychnine by digesting the chromate of strychnine in ammonia, when the alkaloid is left in a state of snowy whiteness.

The amount of strychnine present in nux vomica, St. Ignatius' beans, and other derivatives of the strychnos tribe, varies from five-tenths to one and a half per cent.

Strychnine is colourless and inodorous, but of intensely bitter taste, one part in one million of water possessing decided bitterness. Its crystalline form is octohedral, or square prismatic. It is only slightly soluble in water, one part requiring seven thousand parts of cold water, or nearly three thousand parts of hot water, for its solution; in round numbers one grain of strychnine is soluble in one pint of cold water. It is insoluble in absolute alcohol, pure ether, or alkaline solutions; but soluble in the essential oils, chloroform, and ordinary alcohol. Strychnine exerts lævo-rotation on a polarised ray, with double the power of brucine. It fuses when heated, but is not sublimeable. Distilled with hydrate of potash it furnishes quinoline.

Strychnine is an exceedingly powerful poison, and has of late years been much used for criminal purposes. A great deal of attention has consequently been bestowed upon it by chemists, and its detection in the various parts of an animal that has been killed by it is now as certain and as easy as that of any of the well-known mineral poisons. The following process by Messrs. Rodgers and Girdwood is one of several, but is perhaps more convenient than some others:—The substance operated upon is digested with dilute hydrochloric acid, one to ten, until it is apparently fluid; the liquid is then filtered and evaporated to dryness over a water-bath, treated with spirit as long as anything is dissolved, the filtered tincture evaporated as before, and the residue treated with water and filtered; this aqueous solution must now be rendered alkaline by ammonia, and agitated in a bottle, or long tube, with about half an ounce of chloroform; after subsidence the chloroform is drawn off by means of a pipette, transferred to an evaporating basin, and the chloroform expelled over a water-bath; the residue must then be moistened with concentrated sulphuric acid, and exposed for some hours to the temperature of a water-bath, by which proceeding all organic matter except the strychnine is destroyed. The charred mass is then treated with water, and the solution filtered to separate the carbon; excess of ammonia is now added, and the solution again agitated with about one drachm of chloroform; if on evaporating a small portion of this chloroform solution, and treating the residue with concentrated sulphuric acid, any charring takes place, the preceding process must be repeated until the strychnine from the chloroform solution remains in a perfectly pure state. Pure strychnine, obtained as just described, or in any other manner, is at once recognised by the following reactions:—The first is known as the *colour* test, and consists in evaporating to dryness a solution of a fragment of the alkaloid on a white plate, and then allowing to flow over it a small quantity of sulphuric acid previously slightly coloured with bichromate, or red prussiate, of potash; on coming into contact, a beautiful violet colour, fading into a rose-red, is produced, if any quantity greater than the one-thousandth of a grain of strychnine is present. Some other oxidising agents produce the same effect. A solution of strychnine also gives characteristic precipitates with tannic acid, terchloride of gold, chromate or bichromate of potash, carbazotic acid, iodine, &c., but these should all be confirmed by the application of the colour test. The *physiological test* recommended by Marshall Hall, consists in placing frogs in the suspected solution, or injecting small quantities of the fluid into the thoracic or abdominal cavity, when tetanic convulsions will ensue if strychnine be present. Strychnine is a powerful base; it precipitates most metallic oxides from their salts, and combines with acids to form a well-marked series of compounds, many of which have been described by Abel and Nicholson.

Hydrofluorate of strychnine ($C_{42}H_{22}N_2O_4$, 4 HF, + 4 Aq.) crystallises in prisms on evaporating a solution of strychnine in hydrofluoric acid.

Hydrochlorate of strychnine ($C_{42}H_{22}N_2O_4$, HCl + 3 Aq.), crystallises in needles, is neutral to test-paper, and even more soluble in water than the sulphate.

Sulphates of strychnine. A *neutral* salt containing (2 $C_{42}H_{22}N_2O_4$, S_2O_6, 2 HO + 14 Aq.) is formed on digesting excess of strychnine in dilute sulphuric acid; it crystallises in small rectangular prisms. The *acid* salt containing ($C_{42}H_{22}N_2O_4$, S_2O_6, 2 HO) is produced when strychnine is dissolved in excess of dilute sulphuric acid; it crystallises in long needles. *Sulphate of strychnine and copper* is a crystalline salt formed when strychnine is boiled with sulphate of copper.

Chromate of strychnine ($C_{42}H_{22}N_2O_4$, CrO_3, HO) falls as a yellow precipitate when chromate of potash is added to a salt of strychnine. It is soluble in hot water, crystallising out in beautiful orange needles on cooling. A *bichromate* also exists.

Nitrate of strychnine ($C_{42}H_{22}N_2O_4$, HO,NO_5) is obtained by saturating strychnine with dilute nitric acid. It crystallises in needles. Heated with concentrated nitric acid it forms nitrate of *nitro-strychnine.*

The following are the principal remaining compounds of strychnine with acids and with metallic salts.

Chloroplatinate of strychnine . .	$C_{42}H_{22}N_2O_4$, HCl,$PtCl_2$
Chloropalladite of strychnine . .	$C_{42}H_{22}N_2O_4$, HCl, PdCl
Chloraurate of strychnine . .	$C_{42}H_{22}N_2O_4$, HCl, $AuCl_3$
Chloromercurates of strychnine .	α. $C_{42}H_{22}N_2O_4$, 2HgCl β. $C_{42}H_{22}N_2O_4$, HCl, 2HgCl γ. 2$C_{42}H_{22}N_2O_4$, S_2O_6, 2HO, 4HgCl
Perchlorate of strychnine . .	$C_{42}H_{22}N_2O_4$, HO, ClO_7 + 2 Aq.
Hydrobromate of strychnine . .	$C_{42}H_{22}N_2O_4$, HBr
Hydriodate of strychnine . .	$C_{42}H_{22}N_2O_4$, HI
Nitrate of strychnine and silver . .	$C_{42}H_{22}N_2O_4$, AgO, NO_5
Phosphates of strychnine .	α. $C_{42}H_{22}N_2O_4$, 3HO, PO_5 + 4 Aq. β. 2$C_{42}H_{22}N_2O_4$, 2HO, PO_5 + 18 Aq.
Oxalates of strychnine . .	α. 2$C_{42}H_{22}N_2O_4$, C_4O_6, 2HO β. $C_{42}H_{22}N_2O_4$, C_4O_6, 2HO
Ferrocyanates of strychnine . .	α. 4$C_{42}H_{22}N_2O_4$, 4HCy, 2FeCy + 16 Aq. β. $C_{42}H_{22}N_2O_4$, 2HCy, 2FeCy + 5 Aq. γ. 3$C_{42}H_{22}N_2O_4$, 3HCy, 3FeCy + 12 Aq.
Hydargyrocyanates of strychnine	α. $C_{42}H_{22}N_2O_4$, HgCy β. $C_{42}H_{22}N_2O_4$, HCy, HgCl γ. $C_{42}H_{22}N_2O_4$, HCl, 4HgCy
Hydrosulphocyanate of strychnine .	$C_{42}H_{22}N_2O_4$, HSCyS
Tartrates of strychnine . . .	α. 2$C_{42}H_{22}N_2O_4$, $C_8H_6O_{12}$ + *n* Aq. β. $C_{42}H_{22}N_2O_4$, $C_8H_6O_{12}$ + 6 Aq.

Chlorine, bromine, and iodine derivatives of strychnine. Chlorostrychnine ($C_{42}H_{21}ClN_2O_4$) is formed by the action of chlorine upon solution of hydrochlorate of strychnine; it combines with acids to form salts. *Bromostrychnine* is produced when bromine is made to act upon hydrochlorate of strychnine. *Iodostrychnine,* or *iodide of strychnine* (2 $C_{42}H_{22}N_2O_4$, I_3), obtained on triturating strychnine with iodine, crystallises from alcohol in orange-coloured scales.

Methyl and ethyl derivatives of strychnine. According to M. Stahlschmidt these compounds are not in the slightest degree poisonous. They are powerfully basic. With iodide of ethyl, strychine gives a crystalline *hydriodate of ethylostrychnia,* or *iodide of ethylostrychnium* ($C_{42}H_{21}(C_4H_5)N_2O_4$, HI), and this with oxide of silver yields bihydrate of ethylostrychnia, or rather hydrated oxide of ethylostrychnium ($C_{42}H_{22}(C_4H_5)N_2O_4$, O, HO. Hydrated oxide of *methylo-strychnium* is best obtained by decomposing the sulphate with baryta water.

Strychnic acid is the name given by M. Rousseau to the product of the action of heat upon a mixture of strychnine, chlorate of potash, and sulphuric acid.

2. *Brucine* ($C_{46}H_{26}N_2O_8$ + 8 Aq.). *Canimarine, Vomicine.* This alkaloid was discovered by Pelletier and Caventou, in the bark of the false angustura, which is the bark of the *strychnos nux vomica,* and not, as was supposed when its name was given to it, of the *brucia antidysenterica.* This alkaloid, like strychnine, is found combined with gallic acid in the bark, and with igasuric acid in the fruits of some of the different species of strychnos.

It may be obtained by evaporation and crystallisation of the mother liquor from the precipitation of chromate of strychnine, already described; or, according to Thénard, by dissolving the soluble portion of the nux vomica bark in water, mixing the solution with a little oxalic acid, and evaporating it to the consistence of a syrup. This is to be treated, at 32° Fahr., with anhydrous alcohol, which dissolves everything but the oxalate of brucine. This salt is then to be boiled in water with magnesia; the precipitated brucine is to be dissolved in boiling alcohol, from which it crystallises on cooling.

When a little water is added to the alcoholic solution of brucine, and the mixture is put to evaporate spontaneously, the brucine crystallises in colourless, transparent, oblique four-sided prisms. By rapid evaporation, pearly scales or crystals, in the form of cauliflowers, are obtained. These crystals contain water; they have a strong bitter taste, which remains for a long time. When the hydrate is heated rather below 212° Fahr., it melts and loses about 16 per cent. of its weight of water; the fused mass is a non-crystallised body resembling wax in appearance. It is decomposed by a strong heat.

Brucine requires 850 parts of cold water and 500 of boiling water for solution. It is readily soluble in alcohol, and even in spirit of wine of specific gravity 0·88: the volatile oils dissolve a small portion of it, but neither the fixed oils nor ether take it up. One of the distinguishing characters of brucine is that the red or yellow colour which nitric acid imparts to it is changed to a fine violet by protochloride of tin.

The salts of brucine have a bitter taste, and most of them are crystalline; they are decomposed not only by the alkalies and alkaline earths, but by morphine and strychnine, which precipitate brucine.

Nitrate of brucine ($C_{46}H_{26}N_2O_8$, 2HONO$_5$, + 4 Aq.) is obtained by adding nitric acid to brucine. It crystallises in quadrilateral prisms, terminated by dihedral summits. When heated, it becomes first red, then black, and afterwards detonates with disengagement of light.

Hydrochlorate of brucine ($C_{46}H_{26}N_2O_8$,HCl) crystallises in quadrilateral prisms obliquely truncated, which are sometimes as fine as hair. It does not alter by exposure to the air.

Sulphates of brucine. The *neutral sulphate* (2$C_{46}H_{26}N_2O_8$, S_2O_6, 2HO, + 14 Aq.) is very soluble in water, and crystallises in long quadrilateral needles. Alcohol dissolves it in small quantity. The *supersulphate* crystallises readily when a little acid is added to the neutral sulphate.

Oxalate of brucine crystallises in long needles, especially when it contains excess of acid.

Phosphates of brucine. The neutral salt (2$C_{46}H_{26}N_2O_8$,3HO, PO_5) occurs in prisms; but the supersalt crystallises in large square tables, which dissolve readily in water, and effloresce by exposure to the air.

Acetate of brucine is very soluble, but uncrystallisable.

Many other salts of brucine, corresponding to the strychnine salts, have also been obtained. *Bromobrucine* ($C_{46}H_{25}BrN_2O_8$) occurs in needles; and the *iodobrucines* are amorphous powders. The nitro-compound, or *cacotheline* as it is termed, is the product of the action of strong nitric acid upon brucine; nitrate of methyl, oxalic acid, binoxide of nitrogen, and water, being at the same time produced. The composition of cacotheline is ($C_{40}H_{22}(NO_4)_2N_2O_{10}$); it is a feeble base. *Ethyl-* and *methyl-brucine* are obtained in the same way as, and have properties similar to, the corresponding strychnine salts.

3. *Igasurine.* According to M. Desnoix, this alkaloid is contained in the mother liquors from the preparation of strychnine and brucine. He gives it the name igasurine from *igasur,* the native name of St. Ignatius' beans [STRYCHNOS *Ignatii,* in NAT. HIST. DIV.]; and describes it as a colourless precipitate, becoming crystalline if left in the mother liquor. Igasurine differs from brucine in being more soluble in boiling water, and in being precipitated by bicarbonate of potash or soda in presence of tartaric acid; it otherwise much resembles brucine. Its physiological action is intermediate between strychnine and brucine. M. Schutzenberger has examined several specimens of igasurine, and asserts that by treating with cold water he obtained nine new alkaloids or *igasurines* from them. Their formulæ and relations to strychnine and brucine are as follow:—

Strychnine	$C_{42}H_{22}N_2O_4$
Brucine	$C_{46}H_{26}N_2O_8$ + 8HO
Igasurine, *a* (very little soluble) . .	$C_{44}H_{26}N_2O_8$ + 6HO
„ *b* (slightly soluble) . .	$C_{36}H_{24}N_2O_{14}$ + 6HO
„ *c* (readily soluble) . .	$C_{36}H_{24}N_2O_8$ + 6HO
„ *d* „ „ . . .	$C_{34}H_{32}N_2O_{16}$ + 6HO
„ *e* „ „ . .	$C_{36}H_{26}N_2O_8$ + 6HO
„ *f* „ „ . . .	$C_{42}H_{30}N_2O_8$ + 6 or 8HO
„ *g* (very little soluble) . .	$C_{40}H_{22}N_2O_{12}$ + 6HO
„ *h* (readily soluble) . . .	$C_{42}H_{26}N_2O_{18}$ + 6HO
„ *i* „ „ . .	$C_{40}H_{26}N_2O_{14}$ + 6HO

The above bases are said to resemble brucine in their chemical characters, but are more soluble in water and alcohol. M. Schutzenberger considers them as products of the successive transformations of brucine under the influence of vital force, and suspects the existence of several more.

Igasuric acid may be prepared from any of the mother liquors resulting from the preparation of the nux vomica alkaloids. Such solutions are saturated with magnesia, boiled, evaporated, precipitated by acetate of lead, the precipitate decomposed by sulphuretted hydrogen, and the filtered liquor evaporated to a syrupy consistence. Igasuric acid then slowly crystallises out in hard crystalline grains, very soluble in water and alcohol, and of an acid styptic taste. The *igasurates* are mostly soluble in alcohol or water, and crystallise with difficulty.

END OF VOLUME V.

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